# EXHIBIT 1.3

# Connectivity Report

# Connectivity Report for Rosemont Copper World Project

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# 1.0 EXECUTIVE SUMMARY

The Rosemont Copper World Project (Project) is a proposed copper mine located on private property owned by Hudbay Minerals (Hudbay) in the Santa Rita Mountains south of Tucson, Arizona. The purpose of this report is to analyze ephemeral drainages within the Project's private land with respect to a physical, biological, and chemical connection to the Santa Cruz River, especially the stretch of the Santa Cruz River known as "Study Reach B" (USEPA, 2015).

This report explores potential connections between on-site washes and Study Reach B by looking at the following data:

1. Physical connection: Tracing potential flow drainages and obstructions using evidence from soil chemistry and visual sediment transport to determine the likelihood of concurrent water throughout the noted feature.

2. Chemical connections: Tracing chemicals carried by stormwater through the ephemeral drainages.

3. Biological connections: Chemical extraction and biological contributions through plant samples, organic matter in soil samples and field investigations to determine biotic integrity.

A physical connection is the determined analysis of a variety of observations to conclude whether water that originates at the Helvetia Project site travels to Study Reach B. Satellite imagery was used to define the potential water flow paths. Field reconnaissance following storm events investigated water scouring marks, visual sediment transport, and residual debris to determine the active drainage channel and path; it is noted that high-water marks are defined for a stream with a regular water level present and are not relevant in this study. All features noted are ephemeral in nature and represent erosional features. The study focused on the Helvetia drainage (named Helvetia Gulch) where there was clear evidence of human alterations to its path by agricultural fields, residential areas, and roadways. Although the natural path of the drainage was diverted, it could be extrapolated as a continuous path from the Helvetia area to the Santa Cruz River. Significant rainfall likely greater than any rain event experienced in the last 65 years (since mining ceased within the study area) would be required for water to reach the Santa Cruz River from the Copper World site based on chemical and sediment transport evidence discussed in this report, as there is no conclusive evidence of contaminants from this area previously reaching the Santa Cruz River.

Geographically, numerous ephemeral drainages contribute to the drainage system feeding the Santa Cruz River and ultimately Study Reach B. The Helvetia drainages compose an insignificant fraction of the watersheds that contribute to its drainage basin. Additionally, most rain events during 2021 that resulted in the Santa Cruz River flowing occurred simultaneously within isolated areas closer to the Santa Cruz River. These isolated rain events occurred through southeast Arizona and made it impracticable to observe water continuously flowing from the Project area to the Santa Cruz River. Sediment samples and stormwater samples focused on determining how far water travelled from the Project site with the premise that the contaminated water originating from historic mine spoils would show a chemical signature in sediment and stormwater samples. Sediment and water chemistry was analyzed by physical transport of solids (total concentrations) and by aqueous form then precipitated solids (leachable, dissolved concentrations).

Chemical connectivity was analyzed using sediment and stormwater samples that were collected at the Helvetia Historic Mine Spoils (Columbia Smelter Slag Dump), Tip Top Mine, and Ridley Mine; downstream to the Santa Cruz River; 16.5 miles through the River to the start of Study Reach B; and through 12 miles of the Study Reach B segment of the Santa Cruz River. Study Reach B begins over 39 miles downstream from the Tip Top Mine and Columbia Smelter Slag Dump; a total of 51 miles of drainages were analyzed. Various chemical constituents including copper, zinc, antimony, arsenic, lead, molybdenum, selenium, mercury, and sulfur were analyzed. These chemicals were highly concentrated in the sediment samples near the historic mine features. Most high chemical concentrations drop dramatically in short distances, 7.5 miles, from the sources, decreasing further with distance. An uptake of chemical elements due to residential disturbance, agriculture, and roadways raised the signature after the 7.5 mile drop and then dropped again showing no elevations of chemicals above background levels beyond 17.4 miles from the site. This indicates that there is no chemical connectivity to Study Reach B section of the Santa Cruz River. A distance of 17.4 miles travelled from the source is a conservative estimate due to the additional residential and commercial sources encountered at 7.5 miles. The stormwater sample findings show that there is no conclusive evidence of any physical sediments or precipitation of contaminants from solution in stormwater above background levels beyond 10.4 miles from site. Results convey that water leaving the Copper World Project site is fully absorbed into the soil within short distances.

With regards to biological connectivity to the Study Reach B, a three-step analysis was performed. First, a biotic integrity assessment was conducted in the field within the Helvetia drainage (from the Columbia Smelter to the confluence with the Santa Cruz River) to confirm satellite imagery assumptions. With the human alterations to the drainage path, erosional features and large amounts of bare ground indicate soil and site instability and poor hydrological functions. These indicators lead to discontinuity of vegetation lining the ephemeral drainage, a lack of biodiversity, and overall poor biotic integrity. Second, an analysis of organic material was measured in the soils under mesquite trees throughout the ephemeral drainage. Organic matter measurements were used to determine if there was material of nutrient value transported via the drainage that would benefit aquatic or plant species downstream. The organic matter contribution of the soil was relatively low throughout the ephemeral drainage with an average value of 2.7%. A third analysis was done to test the effect of potentially contaminated water that would uptake into plants that could eventually die and be transported downstream. Mesquite trees provided a natural extraction of chemicals from the soil and water that included zinc, molybdenum, and selenium. Selenium in plant leaves dropped below the local mean at 3.0 miles, and zinc below local mean at 4.0 miles below the source. Although molybdenum was extracted by plants, it was disqualified as a tracer as mesquite trees are likely extracting it from the groundwater rather than the surface flow.

To summarize, the combination of these complementary biological studies show that plant uptake of available contaminants does not persist beyond 4.0 miles from the Project site, the soil is devoid of organic material that is not likely to contribute beneficially to aquatic or plant species downstream, and discontinuous vegetation contributing to poor biotic integrity concludes that there is no biological connectivity to the Santa Cruz River let alone Study Reach B located 16.5 miles further downstream of the Santa Cruz River confluence. The chemical signature in sediment does not persist more than 17.4 miles from the Project site, and the chemical signature in stormwater does not persist more than 10.4 miles from the Project site. Based on the data collected and analyzed in this study, it is clear that there is no physical, chemical, or biological connection between the Helvetia area and Study Reach B of the Santa Cruz River.

# 2.0 INTRODUCTION

The Rosemont Copper World Project (Project) is located approximately 25 miles southeast of Tucson, Arizona within the historic Helvetia mining district on private lands owned by Hudbay Minerals (Hudbay). Ephemeral drainages (washes) within the Project's private lands may be considered jurisdictional under the Clean Water Act but they must compose a "significant nexus" to a downstream "traditional navigable water" (TNW) by exhibiting a physical, biological, and chemical connection. The objective of this report is to determine if there is a chemical, physical, and biological connection to a TNW through a scientific study. Hudbay asserts that the nearest downstream TNW is located at the confluence of the Gila River and the Colorado River near Yuma. However, to be conservative, this study examined the connection of the Project site to the area noted in Figure 1 below as Study Reach B (SRB).

The historic town of Helvetia is located on the western flank of the Santa Rita Mountains. The Columbia Smelter slag dump, located just south of the Helvetia townsite, was used to process the copper ore and slag from the smelting process was deposited directly into the wash. Several small mines and numerous other mine workings are located in the hills surrounding Helvetia, including Tip Top Mine to the north and Ridley Mine to the southwest, both have visible waste piles of potentially acid generating material deposited near drainages. These mines and the smelter were identified as potential sources of chemicals to trace downstream. To the northwest, the foothills of the Santa Rita Mountains fade to an alluvial fan that drains during episodic precipitation events through ephemeral drainages and eventually to the Santa Cruz River that runs south to north in the valley bottom. See Figure 1 for an overview of the sampling areas.

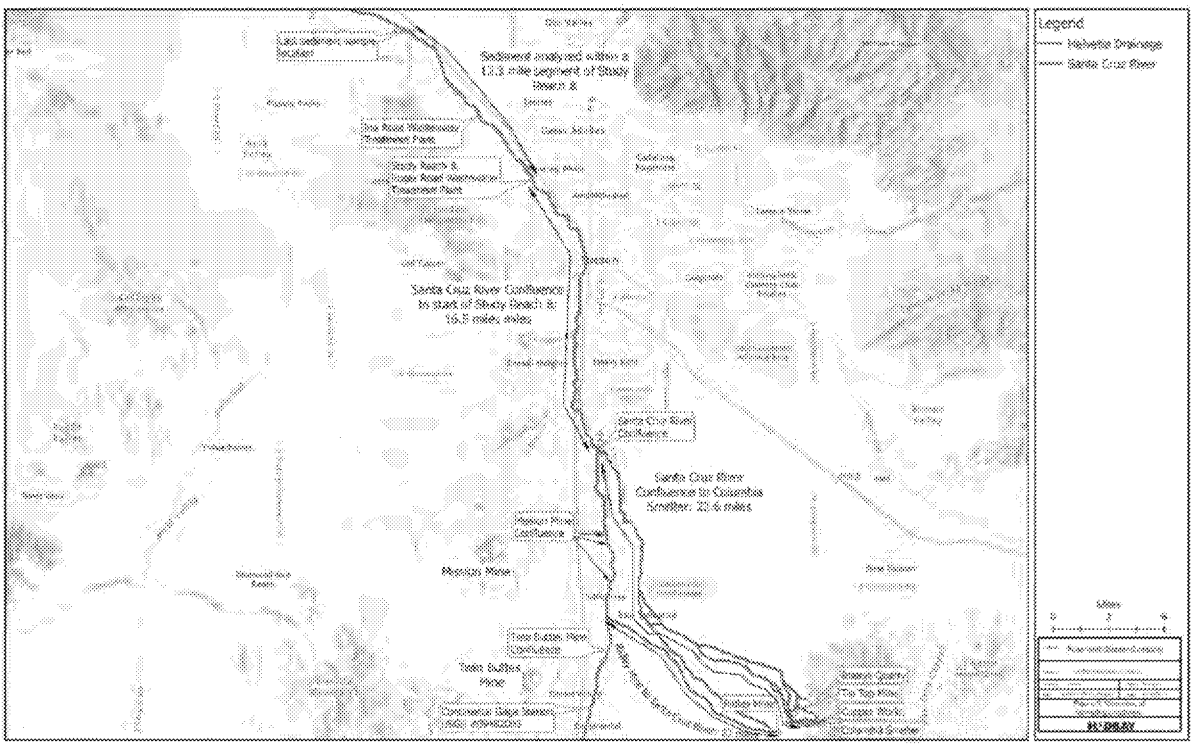

**Figure 1. Overview of Sampling Locations. Note the location of Study Reach B, which will be assumed the TNW.**

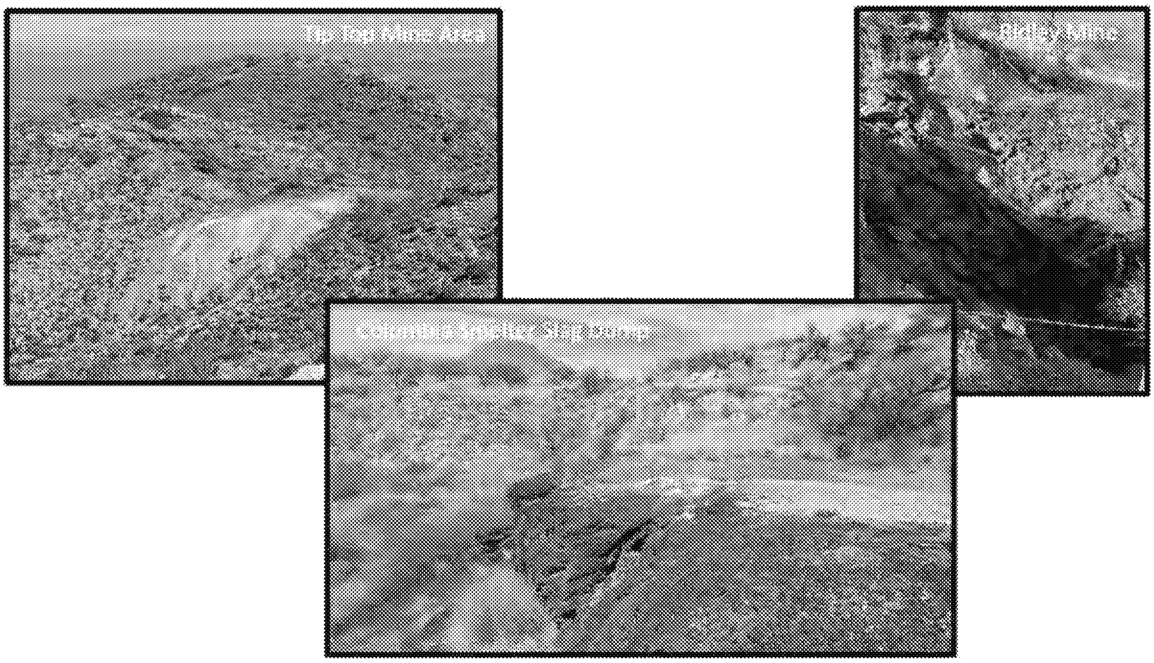


**Figure 2. Photos of Source Locations. Tip Top Mine (in production from 1899 – 1956), Ridley Mine (1909 – 1929), Columbia Smelter Slag Dump (1903 – 1951) are used as source locations for potential uncontrolled contaminant release in the ephemeral washes studied.**

This study analyzed stormwater and sediment samples to trace chemicals carried by erosion and stormwater through ephemeral drainages to SRB. Plant leaves of mesquite trees located on the margins of the drainage were analyzed for their potential to uptake these chemicals (phytoextraction), their contribution to organic matter, and assessed for biotic integrity using rangeland health indicators along the primary Helvetia drainage.

The *404 Connectivity Sampling and Analysis Plan: Rosemont Copper Company, West Side Properties* (Hudbay 2021), provides the methodology and locations for the physical connectivity investigation, sediment (soil) sample collection, and biological sample collection. The surface geomorphology was used to define the path in which the potential chemicals would travel and settle within. A total of 5 drainages were investigated in addition to portions of the Santa Cruz River. To better understand the SRB itself, sediment samples were collected within the effluent discharge segment of the Santa Cruz River beginning at the Agua Nueva Wastewater Reclamation Facility outfall near Roger Road in Tucson. Last, biological samples were collected from a species that occurs from Helvetia to the confluence of the Santa Cruz River and within the erosional channel of the drainage. The extent of the physical connectivity relies on the chemical signature derived from the sediment samples.

Physical connectivity refers to the extent to which episodic flows of water have the potential to reach water a TNW, in our case the Colorado River. In this study we aim to relate the transport of sediment particles and other solid material from the Helvetia area to SRB as a proxy for a significant volume of water reaching that distance on at least one occasion or event. Secondly, we also infer that with increased flow frequency, the accumulation of contaminants should be at an increased level when measured in the sediment. Therefore, increased levels of contaminants, or constituents of concern (COCs), could indicate that the drainage incurs more frequent wetting events that originated from the contaminant source. Such COCs represent potential compromises to water quality in the river system and include, for example, copper. These particles may degrade over time and release their constituents to receiving water.

Chemical connectivity speaks directly about COCs that are in water that reach the SRB segment of the Santa Cruz River. The COCs analyzed may be derived from source material in the Helvetia area or as precipitate that has travelled in aqueous form to their current location. They could be remobilized from the alluvial sediments upon re-exposure to water under the right pH conditions.

Biological connectivity refers to the extent to which a drainage supports the capacity to transfer nutrients and organic carbon vital to support downstream food webs (e.g. macroinvertebrates present in headwater streams convert carbon in leaf litter making it available to species down streams). Soils were sampled for organic content and plants were tested for chemical absorption to determine the proximity of plants affected by COCs in sediments or water. Organic matter is a form of a biological passive connection, dependent on water flowing. Ephemeral drainages bordered by continuous vegetation that provide wildlife movement corridors and xeroriparian habitat also a form passive biological connectivity and reflect biological integrity. Invasive species, poor species diversity, and poor hydrological functions threaten biotic integrity and therefore biological connection.

Each potential connectivity aspect will be described in detail in the following sections. The methodology is presented in further detail in **Attachment A**. Observations and results are included in **Attachments B through D** and are summarized in Section 4. An explanation of sediment sample D1-19 can be found in **Attachment E**. Photographs of each sampling location are included in **Attachments F through H**.

The remainder of this *Connectivity Report* is divided into the following sections:

Section 3.0 presents the sampling methodology;

Section 4.0 presents the study results with an explanation of the results;

Section 5.0 presents conclusions; and

Section 6.0 provides a list of references.

# 3.0 SAMPLING LOCATIONS AND METHODS

A total of 5 drainages were verified in the field to study. The drainages were chosen as they are primary drainages, with the widest spans and deepest channels found within the area as seen from satellite imagery, that come from the Helvetia area and have potential sources of chemicals to trace.

1) Drainage 1 (D1) named Helvetia Gulch begins east of the Copper World Mine in the foothills of the Santa Rita Mountains and flows past the Columbia Smelter and then to the northwest.

2) Drainage 2 (D2) originates near Ridley Mine makes a path to the west/northwest and connects to the Santa Cruz River south of Sahuarita.

3) Drainage 3 (D3) flows through the Imerys marble quarry and flows to the northwest until it joins with the Helvetia drainage.

4 and 5) Drainages 4a and 4b (D4a, D4b) consist of 2 drainages that begin below the Tip Top Mine that is located on a ridge north of Peach Knob. Drainage 4a (D4a) flows east (D4a) and Drainage D4b (D4b) flows west. Each of these tributaries later flow north-northwest into the Imerys drainage (D3).

Figure 3 (below) illustrates the locations of these 5 drainages.

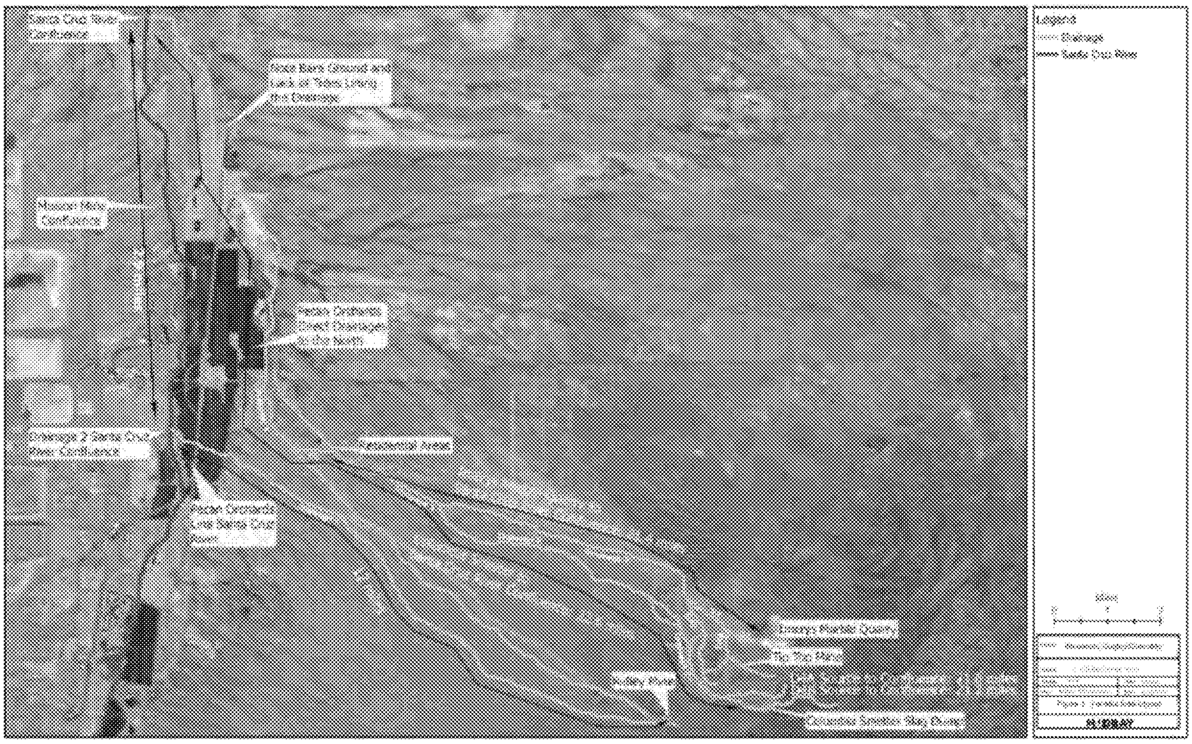

**Figure 3. Locations of Drainages Studied. The 5 drainages that were studied include the Helvetia Gulch (D1), a drainage that begins near Ridley Mine (D2), a drainage that begins near the Imerys marble quarry (D3), and 2 tributaries that drain to the west and east of Tip Top Mine (D4a and D4b). Data was also collected from the Santa Cruz River.**

Sediment samples were collected up to 22.6 miles downstream from below the Columbia Smelter (D1) down to the confluence with the Santa Cruz River plus 28.4 miles downstream of the confluence within the Santa Cruz River for a total of 51 miles of washes analyzed. Approximately 12 additional miles of drainages were analyzed in Drainage 2 (D2) from Ridley Mine to the Santa Cruz River confluence.

The bright white color of limestone below the marble quarry imagery can be seen in satellite and aerial imagery. This makes the D3 ephemeral wash unique among surrounding drainages. Field reconnaissance confirming limestone made calcium a predictable tracer. Photographs, Munsell color values, and visual descriptions of D3 also were used to document the limestone-based tracer to help determine the distance that limestone travels.

Physical tracing, sediment sampling, and biological samples were collected as described in the *404 Connectivity Sampling and Analysis Plan* (SAP; Hudbay 2021). Stormwater samples and quality assurance/quality control measures were conducted as described in the *Rosemont Copper Project Water Programs Quality Assurance Project Plan (QAPP) – Existing Conditions* (QAPP: Hudbay 2021b).

Sediment samples were analyzed using EPA Methods 3050 and 1312. Analyses were conducted by ACZ Laboratories in Steamboat Springs, Colorado. The samples were chemically analyzed for the chemical constituents shown in the SAP (Hudbay 2021). Stormwater samples were analyzed by Turner Laboratories in Tucson, Arizona as described within the QAPP.

The lab used EPA Method 3050, a strong acid digestion followed by analysis of the digestion solution using inductively couple plasma (ICP) spectroscopy, to assay the elemental content of sediments to assess the physical movement of sediments by water (erosion). It does not address the chemical reactivity of the sediment particles. EPA Method 1312 (Synthetic Precipitation Leaching Procedure (SPLP)) is a very weak digestion of the sediment solids followed by the same ICP analysis. Method 1312 recovers only those elements that are very easily released from the solid upon contact with water, used to simulate chemicals that would be released during stormwater transport.

# 4.0 RESULTS

## 4.1 PHYSICAL CONNECTIVITY RESULTS

Five (5) drainage features (D1, D2, D3, D4a, D4b) with potential water flow were investigated and traced from the western flank of the Santa Rita Mountains down to the Santa Cruz River.

Analyzing drainages from north to south, D3 originates near the Imerys marble quarry and flows to the northwest until it joins with the Helvetia drainage (D1). D4a and D4b begin near Tip Top Mine flow into the Imerys drainage (D3).

The majority of stormwater coming from Helvetia flows northwest until it is diverted into a man-made channel prior to reaching Dawson Road. The channel is used to keep water from flowing across the road except at designated points. This diversion sends the water west until it crosses Dawson Road at Country Club Road, converging with 2 other drainages before this point. As the determined D1 path continues downstream it turns and continues to flow north (as compared to northwest as all natural surrounding drainages flow) as directed with berms and dykes located along private lands. To the north of Sahuarita Road, the drainage continues to flow north along the eastern edge of the pecan orchards within a man-made channel, then around a quarry and along the base of the train tracks before the drainage takes a relatively sharp left turn under Nogales Highway. After a short stretch flowing to the west, D1 takes a relatively sharp right turn to the north. It appears that the drainage was man-made or highly altered for the construction of Nogales Highway and to protect private property located to the east of the drainage. The alluvial banks of D1 on the west side of the Highway are tall and highly eroded, suggesting that it is relatively new in terms of geological time.

It is likely that, historically, D1 once flowed directly to the Santa Cruz River, but it has been diverted and the present connection is uncertain. For the purposes of the present evaluation, a potential flow path for D1 to connect to other drainages and ultimately reach the Santa Cruz River is assumed and distances upgradient to each sediment sampling location have been estimated for consistency. See Figure 4 to view physical barriers and diversion locations and Figure 5 to see berms that are used to direct flow.

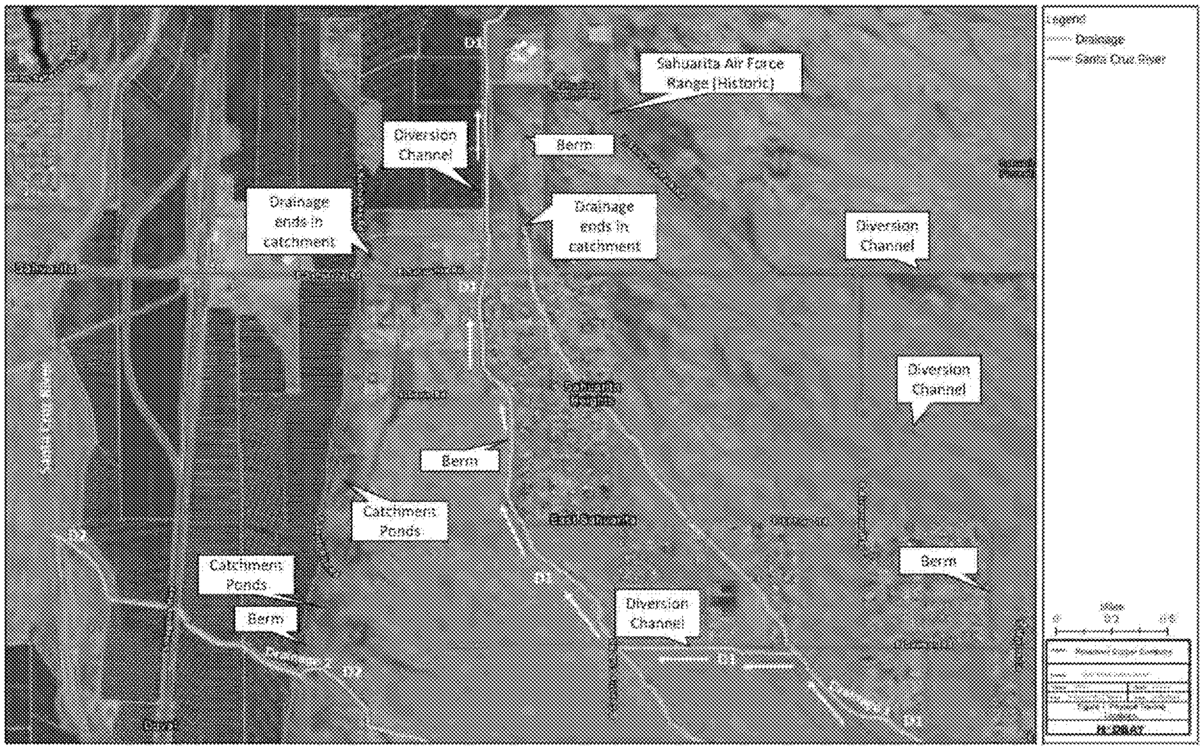


**Figure 4. Physical Tracing Locations. Note the number of alterations to the natural flow paths. Drainages are diverted around roadways, residential areas, and pecan orchards. Direction of flow is changed to the north around the orchards; the natural flow path is generally northwest. Numerous small tributaries from surface runoff can be observed contributing to the larger drainages as they flow downstream.**

**Figure 5. Berms lining property (Sanrita West property) to create flow path shown in center of Figure 4 above.**

Drainage D2 begins slightly upstream of Ridley Mine, joins a larger drainage approximately 600-feet downstream, then it makes a clear path to the west down the alluvial fan. On the western end of D2, there are diversion channels and dykes built up to protect run-on stormwater from running through the pecan orchard (as seen in **Figure 6**). An engineered channel directs the water through the pecan orchards and connects to the Santa Cruz River. These dykes were found on the eastern edge of the majority of the orchard as seen along Drainage 1 north of Sahuarita Road.

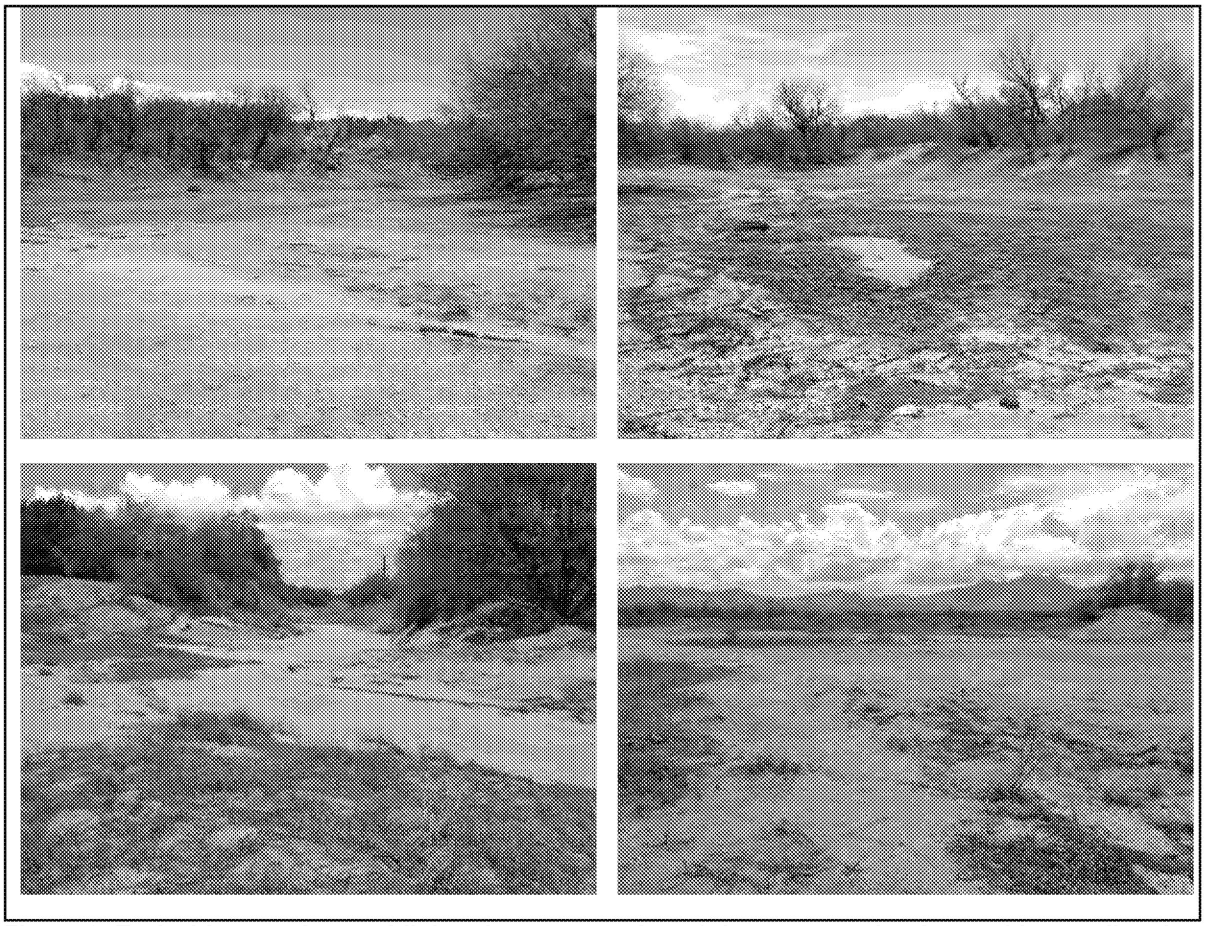

**Figure 6. Typical berms observed lining the eastern edge of the pecan orchards, catching or diverting water away from the orchard.**

As discussed in EPA (2015), river systems in the arid southwest are, like wetter climates, intimately linked with an arterial network of smaller drainages. This network delivers stormwater runoff to the river system and is largely responsible for its existence. In the arid southwest, this network commonly consists of ephemeral drainages that only occasionally and sporadically delivers water to the river system. This is the case with Helvetia and the Santa Cruz River in southeastern Arizona and is clearly evidenced by the incised arroyos in the alluvial fan propagating out and away from the Helvetia area and the Santa Rita Mountains.

The presence of periodic hydrologic activity through scouring, debris, and visual observation suggest that the Helvetia drainages are a series of distributary drainages with most terminating naturally, others blocked by physical barriers and two were traceable with extrapolation to the Santa Cruz River. Despite the connectedness of channels, there is no evidence that water originating at Helvetia makes it to the Santa Cruz River. With precipitation occurring across the landscape with numerous drainages contributing to the drainage, chemical investigations are relied on to determine if, how far, and to what extent the Helvetia drainage is physically connected to the Santa Cruz River. As mentioned above, the Santa Cruz River and SRB are referenced for context and is not implied to be TNW's. As will be detailed in the following sections, chemical, biological analysis, as well as the orthographic indicators of limestone silt all corroborate that water never makes it further than 17.4 miles from Helvetia.

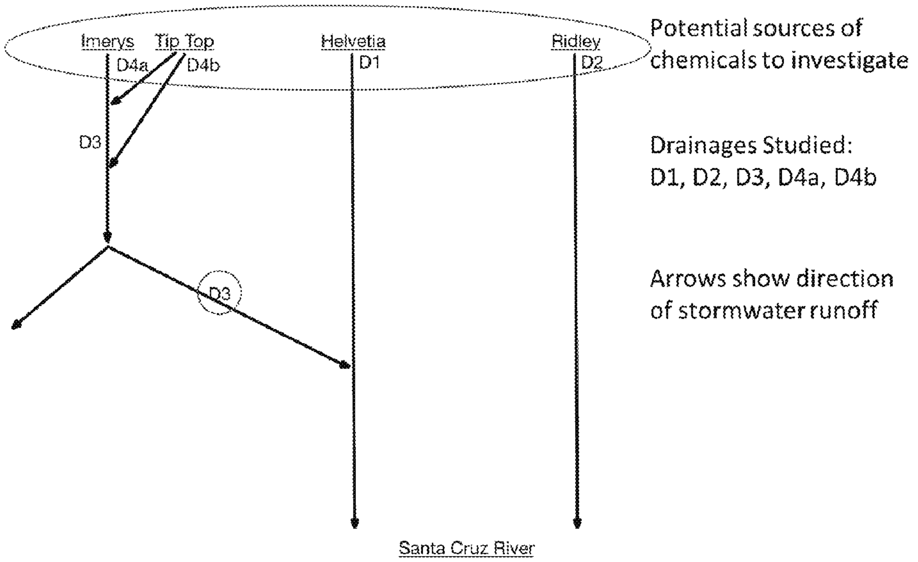


**Figure 7. Drainage Flowchart.**

## 4.2 CHEMICAL CONNECTIVITY RESULTS

Suitable chemical tracers were used to assess the extent to which water physically carried particles (total concentrations) or contaminants in solution (leachable concentrations) from the historic Helvetia district to the Santa Cruz River and ultimately to SRB. The tracer elements analyzed include antimony, arsenic, copper, lead, mercury, molybdenum, selenium, and zinc. These chemical constituents were observed to be elevated above global average concentrations (Mason and Carleton 1982) and local means (USGS 1970; The Earth Technology Corporation 1991). Sulfur, while not highly enriched in sediments of the Helvetia area, is strongly associated with local mineralization and was also selected for the evaluation. Understanding the conditions of water transport regarding physical and chemical connectivity is assessed in the present report using these tracers.

The chosen chemical constituents represent different types of geochemical behavior in the environment. Copper, zinc, and mercury are metals, antimony is a metalloid (sharing characteristics of metals and non-metals), and sulfur is a non-metal that is generally reactive when exposed to air and water and is associated with historic metal production in the Helvetia area.

Total concentrations of chemicals represent physical transport, including erosion, of chemicals within sediment. The sediment is nearly completely digested using an acid to determine its concentrations. As shown in **Figure 8** below, total copper concentrations in drainage D1 decrease rapidly in a short distance from highly enriched concentrations in the vicinity of the Tip Top Mine to only 3% of the source's concentration prior to reaching the main D1 drainage, approximately 2 miles downstream. By sampling locations along Dawson Road and at Sahuarita Road, concentrations are very low and continue to stay low through the Santa Cruz River.

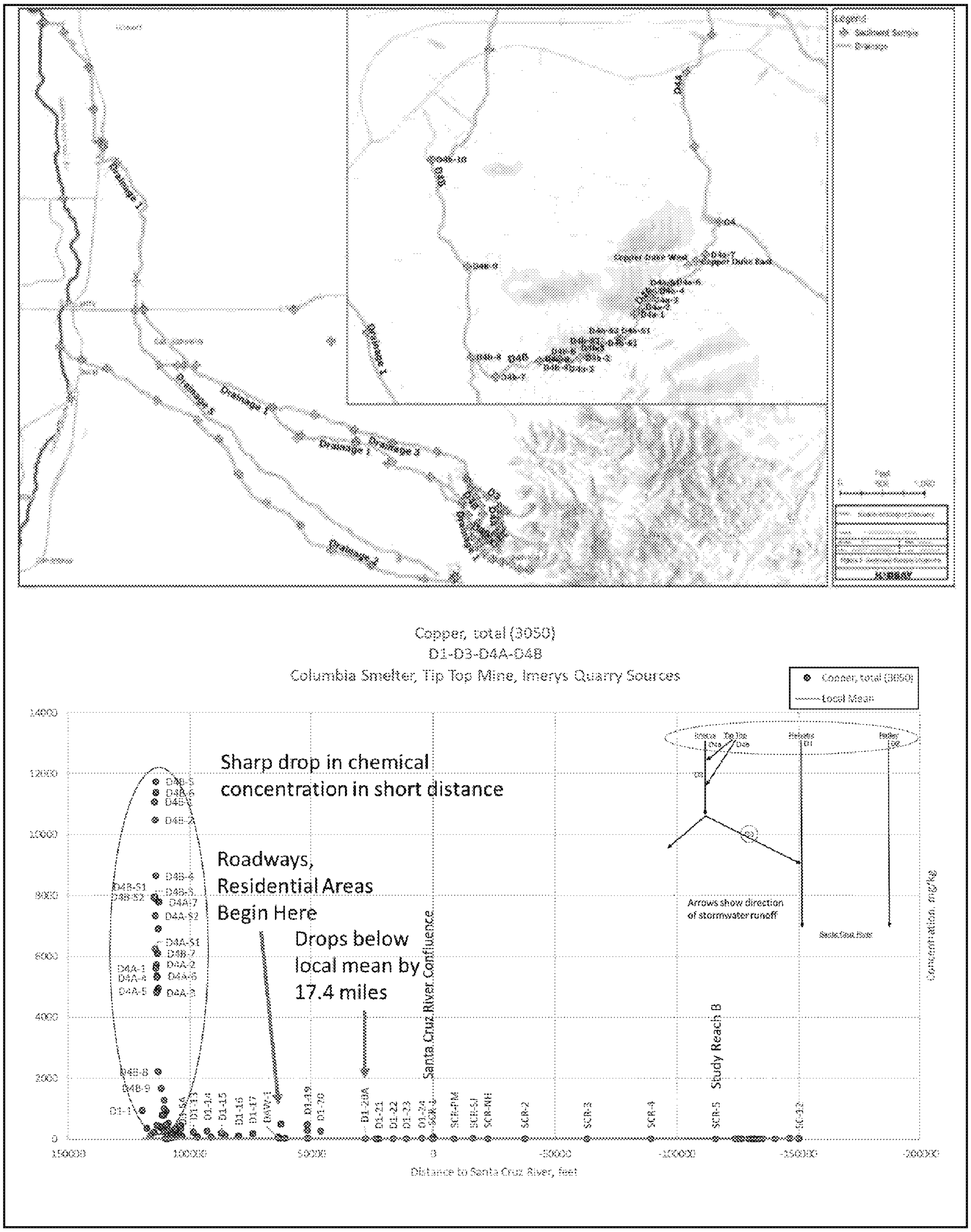


**Figure 8. Total Copper Concentration in Drainages 1, 3, & 4. Copper concentration drops to local background level within 17.4 miles of the source location. The zero distance on the graph refers to the intersection of the ephemeral drainages with the Santa Cruz River and the negative distances refer to downstream distances within the Santa Cruz River to Study Reach B.**

An anomaly occurred off the primary D1 path, at D1-19. A memorandum (found in **Attachment B**) provides an explanation about elevated copper concentrations found at this point: landscaping rock that was derived from mine waste rock provided a source of copper. Once human development occurs across the drainage, there is a potential to introduce an array of chemicals into the drainage.

A study conducted by the USGS in Pima County (USGS 1970) traced chemicals in sediment up drainages in an attempt to locate copper deposits beneath alluvium. The study began in the Santa Cruz River and traced chemicals to the Sierrita Mountains located west of the Santa Rita Mountains, where the current study was conducted. The study concluded that background levels of copper concentration ranged from 10 to 20 parts per million (ppm), equivalent to 10 to 20 milligrams per kilogram (mg/kg). A review titled "*Evaluation of Background Metals in Arizona Soils*" (The Earth Technology Corporation 1991) concluded a similar baseline, an average concentration of 16.6 mg/kg. The remaining results can be seen below in Table 2. The USGS study (1970) also concluded that there was a natural increase of chemicals within the sediments caused from the geological formation of the deposit. While the weathering of rocks and sediments from mine tailings may provide a source of chemicals at the Project site, the chemicals may also be found naturally from the formation of the geological deposit.

**Table 1. Concentrations of Background Metals in Arizona Soils (**The Earth Technology Corporation 1991).

| ADEQ Soil Samples | | | | |
|---|---|---|---|---|
| Concentrations of Metal | | | | |
| Evaluation of Background Metals in Arizona Soils" (The Earth Technology Corporation 1991) | | | | |
| **Metal** | **Average (mg/kg)** | **Standard Deviation (mg/kg)** | **Maximum (mg/kg)** | **Minimum (mg/kg)** |
| Antimony | 1.7 | 1.81 | 3.8 | <0.4 |
| Arsenic | 9.4 | 3.8 | 24 | 3.1 |
| Copper | 16.6 | 5.9 | 27 | 6 |
| Lead | 7.7 | 4.8 | 24.5 | ND |
| Mercury | 0.05 | 0.2 | 0.25 | ND |
| Nickel | 18.2 | 5.3 | 28 | 9.2 |
| Selenium | 0.6 | 0.3 | 1 | <0.4 |
| Zinc | 38.9 | 16.4 | 81 | 15 |

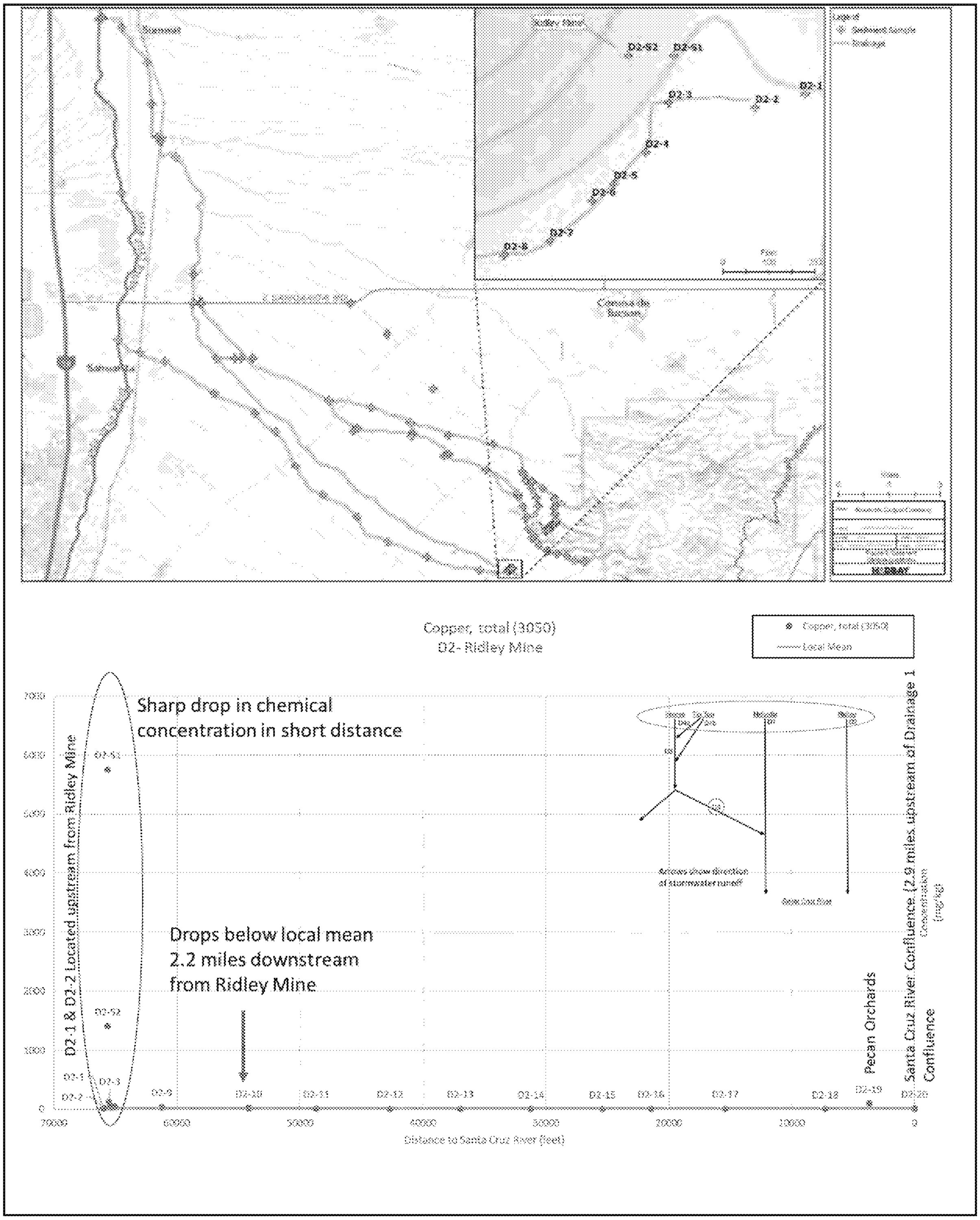


**Figure 9. Total Copper Concentrations in Drainage 2, Ridley Mine Area. Copper concentrations drop below local background 2.2 miles from site and stays at below background until new influences are introduced at the pecan orchards. This location acts as control for background levels for the area.**

Drainage 2 (D2) starting at Ridley Mine was used as a control group. Although D2 is not a proper control with no disturbances within it, the D2 drainage is relatively unaffected from Ridley Mine as chemical concentrations are only seen in the tailings or immediately below the mine. The remaining drainage results become steady low values below local average values that continue until the pecan orchard. In comparison to Drainage 1, drainage D2 also displays a substantial decrease in copper concentrations within a short distance from the Ridley Mine area, quickly reaching background concentrations as seen in **Figure 9**. The very low concentrations of copper concentrations, lower than global and local averages, and are deemed to be an acceptable estimate of approximate background conditions. Local and state studies verify that D2 displays background level concentrations approximately 2.2 miles downstream of Ridley Mine, using 20 mg/kg of copper as a baseline concentration. A complete set of graphs for total concentration of elements within the Helvetia drainages and Santa Cruz River can be found in **Attachment C.** A sediment sample photo log can be found in **Attachment D**.

The profile of total copper concentration in sediments for both D1 and D2 clearly indicates that physical transport of solid sediment by ephemeral stormwater flow does not carry material long distances, and in particular from the Helvetia area to the Santa Cruz River system. As mentioned above, other chemicals were observed with elevated levels and used as tracers. These chemicals exhibited similar trends as that seen with copper, decreasing rapidly from the chemical source and decreasing further with distance. Figure 10 displays that most elements drop to background levels by 7.5 miles from the source, but once human intervention enters the drainage at Dawson Road (residential areas, pecan orchards, roadways), chemical concentration anomalies are observed. These anomalies make for a conservative determination that all chemicals analyzed travel a maximum distance of 17.4 miles from the Project site. Overall chemical concentrations decrease over distance to SRB with generally low concentrations through SRB.

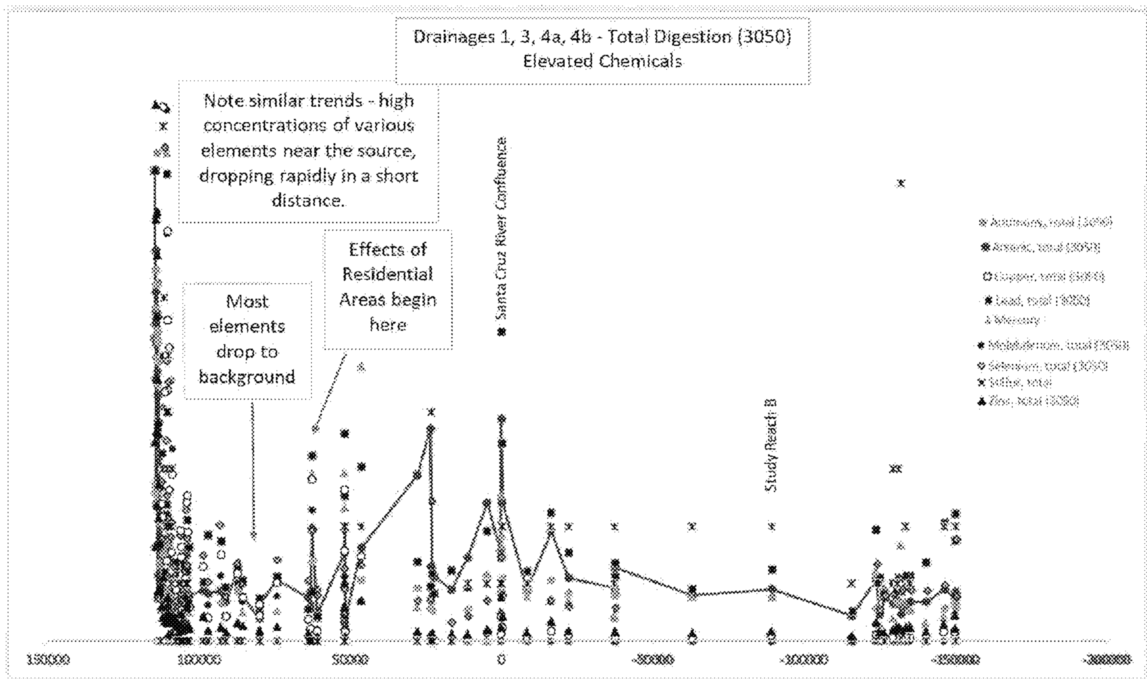


**Figure 10. Total Acid Digestion for Drainages 1, 3 & 4. All elements show similar trends of decline to background levels and do not reach the Santa Cruz River. The anomalous values that occur in residential and road areas are likely caused by introduction of foreign material.**

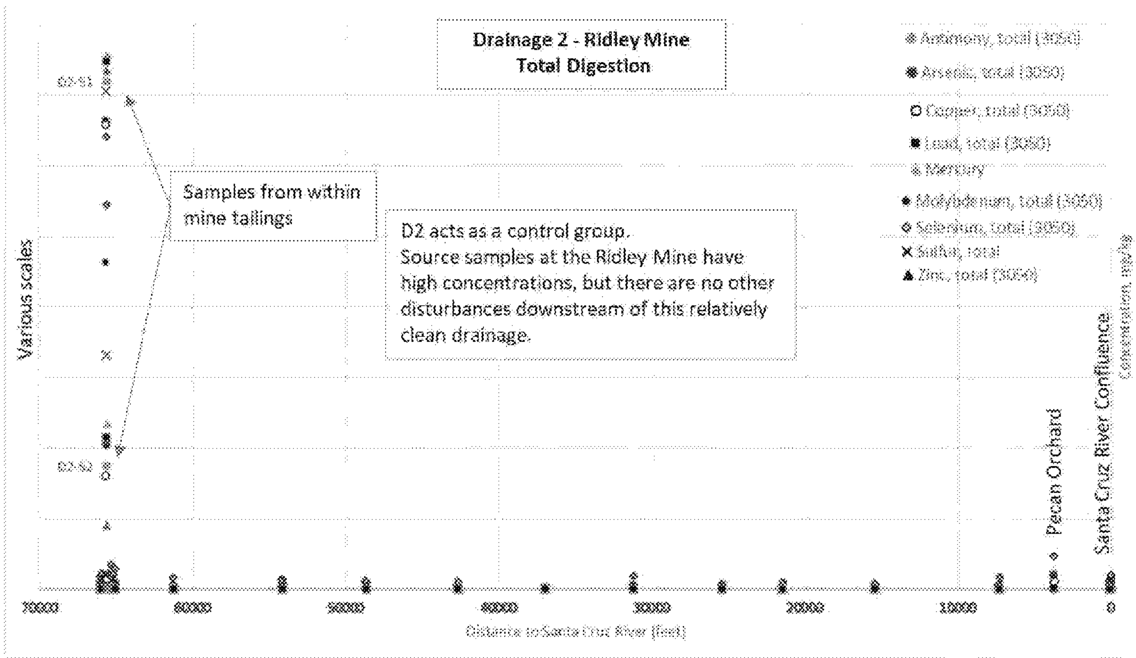


**Figure 11. Total Acid Digestion for Drainage 2, Ridley Mine Source. Elevated levels of chemicals observed within the Ridley mine tailings and drops to background levels nearly immediately. This drainage acts as a control as it this compilation graphs show that it is relatively free of chemicals.**

A compilation of the chemical constituent tracers for Drainage 2 (Ridley Mine) are seen in **Figure 11.** Again, D2 acts as a control, quickly returning to background concentrations as seen above for copper. As D2 passes through the pecan orchards, an increase of identified chemicals can be observed. Similarly, the total constituent concentrations support a lack of physical connectivity between the Ridley Mine and the Santa Cruz River system. Other elements provide additional documentation that chemical elements that are enriched in the Helvetia area are not transported by water-borne erosional processes to the Santa Cruz River system and, hence, fail to demonstrate the physical criteria of connectivity.

### 4.2.1 Sediment Sample Results, Leachable Metals

Leachable chemical constituents, as represented by a SPLP leach test, may be derived from either salts that are left behind as earlier water flow evaporates or produced by copper oxides that were transported downstream from upgradient mineralized areas like Helvetia. The relevant point is whether the copper oxide was chemically precipitated at the sample location or whether it is a grain of copper oxide transported by a rain event as a solid. Both pose the opportunity to release copper back to aqueous solution should the pH of the water it interacts with is in the range of 4. The results presented below show that presence of limestone limits aqueous mobility. Based on site conditions and field observations, the majority of the leachable copper coming off the site was in solution versus being transported as solid particles. The interaction with limestone created a rapid change in pH, causing the precipitation of metals.

Chemical constituents that are picked up by flowing surface and delivered to the Santa Cruz River system would constitute a chemical connectivity. Using a SPLP leach test provides an assessment of which elements are easily transported through solution such as stormwater.

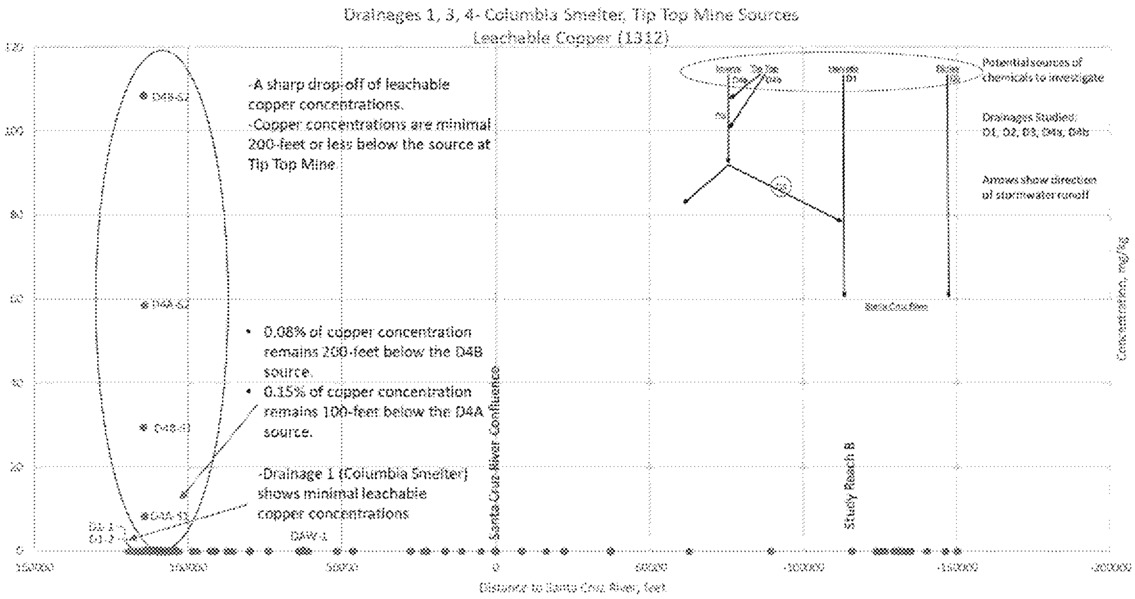


**Figure 12. Leachable copper concentration in Drainage 1, 3 & 4. Graph illustrates that Drainage 4 leachable copper (transported or precipitated copper oxide) does not transport easily from source location, likely due to the high limestone content in the wash which quickly neutralizes any acidic stormwater required to keep the copper in solution.**

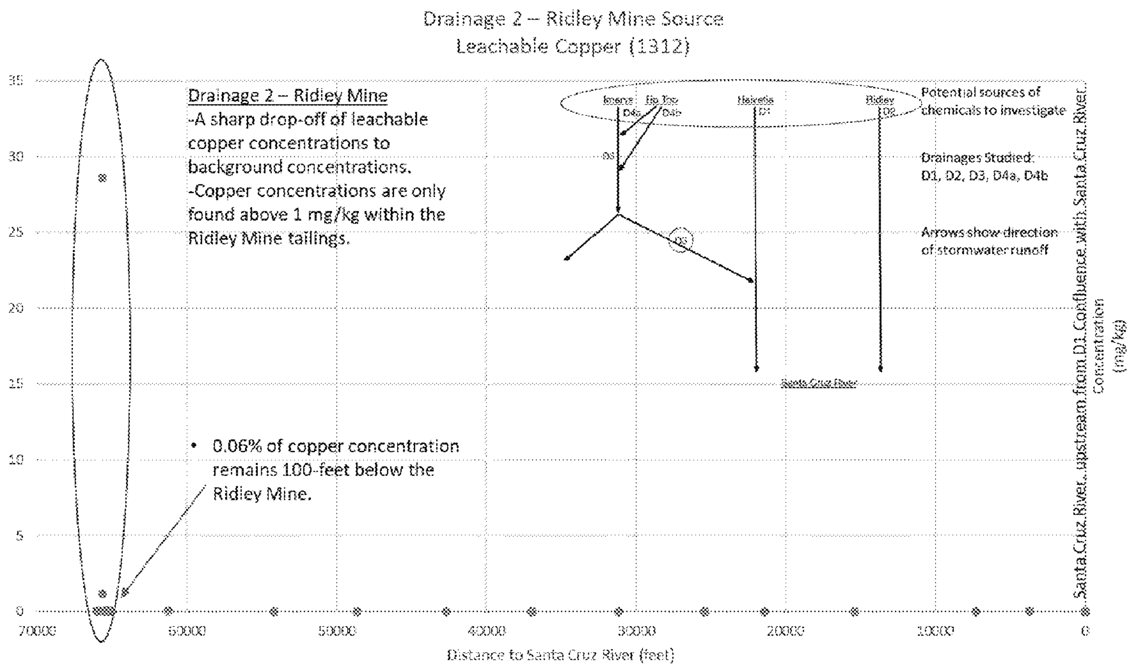


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**Figure 13. Leachable copper concentration in Drainage 2 - Ridley Mine source. Note that copper concentrations are not elevated other than within the source. This indicates that copper does not move easily in solution. Background concentrations also indicate that Ridley Mine acts as a control.**

Very much like the profiles for total copper and other enriched elements in sediment of drainages D1 and D2 (**Figures 8 – 11**), easily leachable (SPLP) concentrations for these constituents display a very rapid decline with distance from the Helvetia area (**Figures 12 – 14**). Data was not obtained for leachable sulfur and are not available for comparison. A complete set of graphs for leachable elements can be found in **Attachment C.** A sediment sample photo log can be found in **Attachment D**.

Significantly, the very low SPLP concentrations indicate that sediments bearing enriched concentrations of chemical elements transported away from the general source area of Helvetia do not themselves represent a source of leachable constituents to stormwater that contacts them. Hence, connectivity between the enriched Helvetia source area via a coupling of physical transport and chemical transport does not appear to be present in the current drainage system.

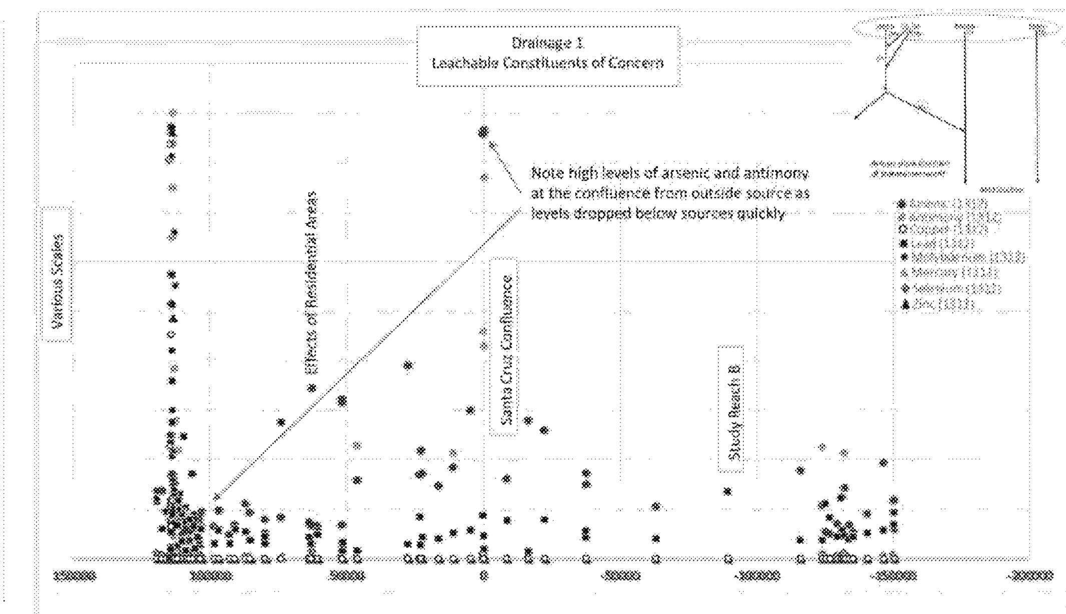
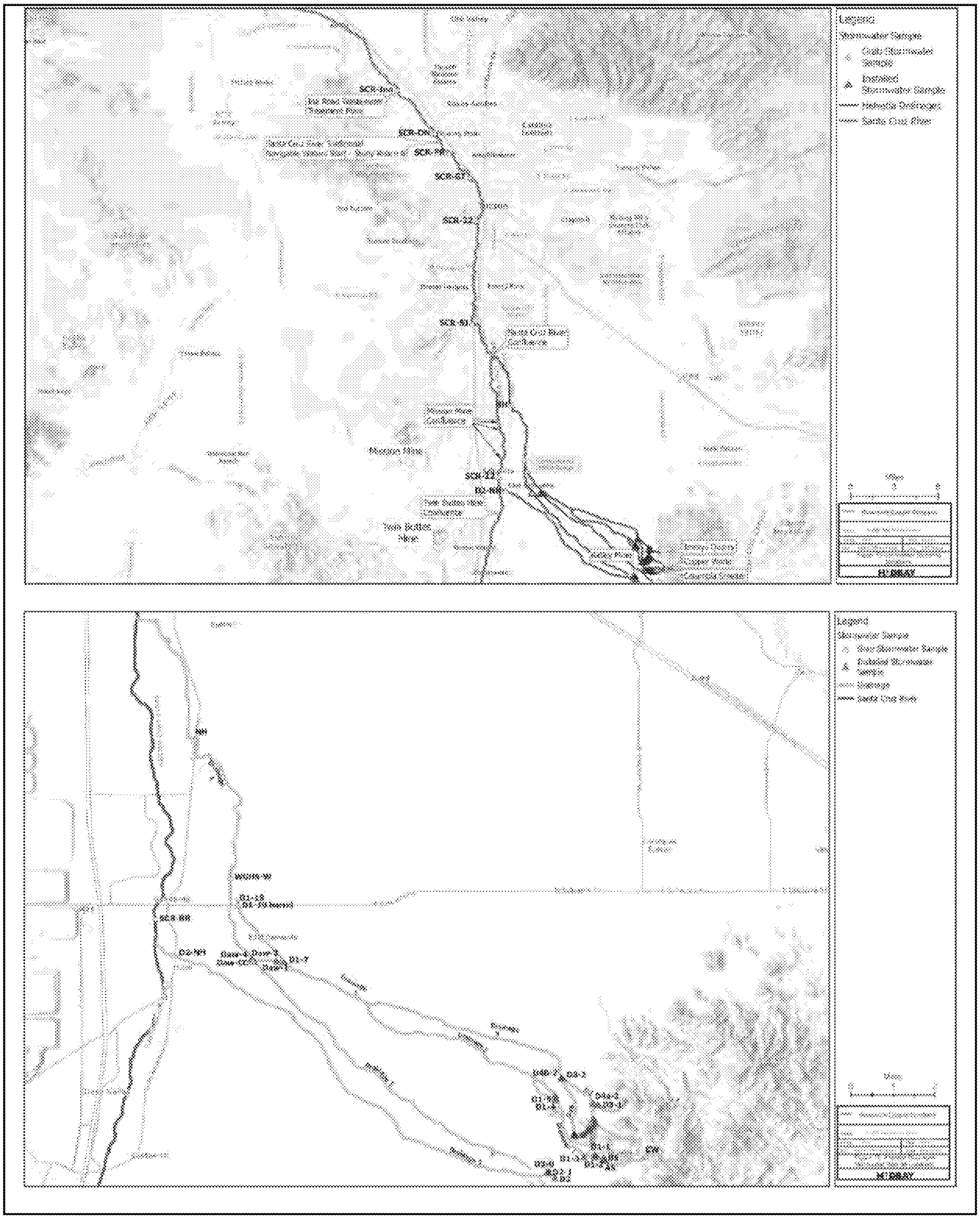



**Figure 14. Leachable elements compilation. Note the trend of chemical concentrations that quickly drop below the source. Anomalies become apparent at the onset of human influences with residential areas and additional contaminants present at the Santa Cruz River confluence.**

### 4.2.2 Stormwater Results, Total and Dissolved Metals

The drainages emanating from the Helvetia area are ephemeral and only occasionally receive water, most often from local rainfall and less frequently from heavy rains at moderate distances. At the time of the present evaluation, episodic rain events resulted in surface water flow in the study area and afforded an opportunity to characterize the chemical quality of these flows. The results are illustrated below for the same elements evaluated for total concentrations (physical transport) and chemical transport (SPLP).

**Figure 15** presents copper concentrations of total and dissolved copper within stormwater samples. It should be noted that the graph includes multiple events at the same location. Concentrations of metals can greatly vary from one storm event to another. A complete set of stormwater graphs can be found in **Attachment D**. A stormwater sample location photo log can be found in **Attachment E**.


Legend
Santa Cruz River
Confluence
Twin Buttes Mine
Mission Mine
Legend
Stormwater Sample

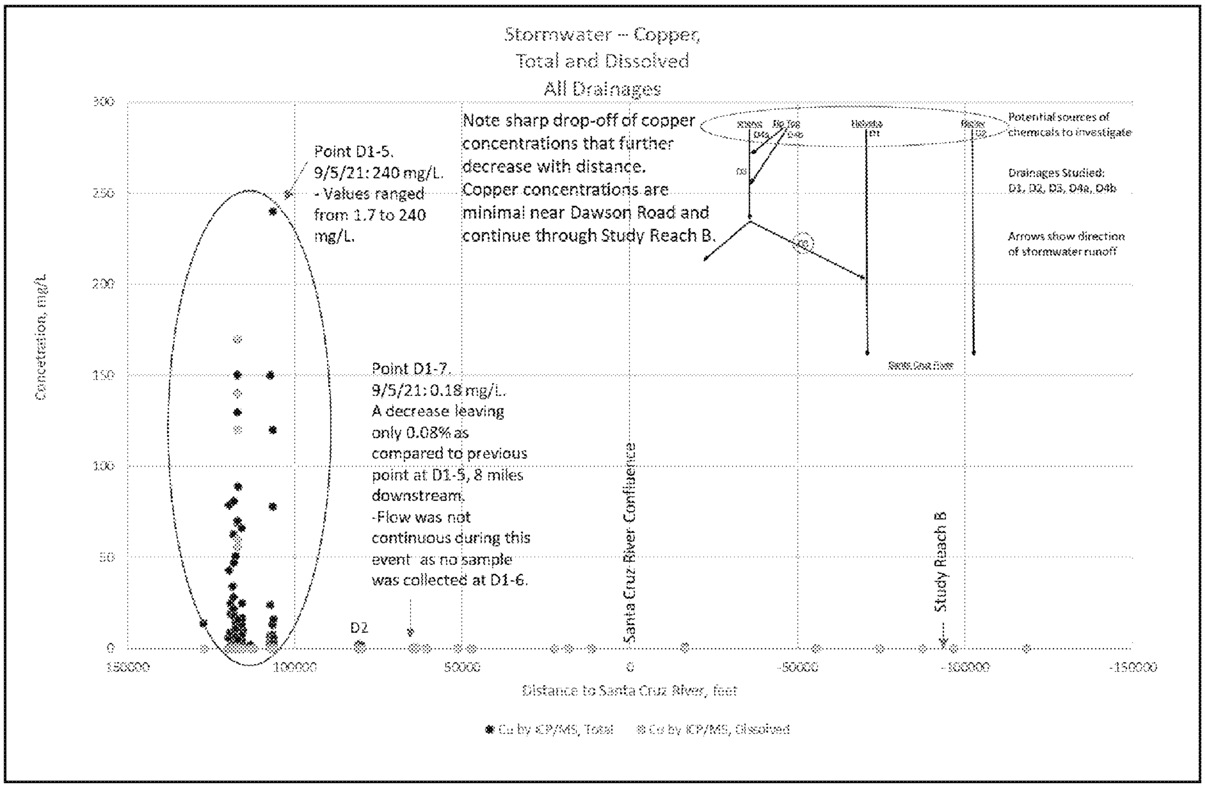



**Figure 15. Total and dissolved copper concentration in stormwater. The sulphide copper is the best proxy for water transported sediment. The dissolved copper remains at very short distances to site because the pH is buffered very quickly with limestone.**

The profile of total copper concentration in stormwater (for both D1 and D2) clearly indicates that physical transport of solids by ephemeral stormwater flow does not carry material from the Helvetia area to the Santa Cruz River system. The profile of dissolved copper concentration in stormwater (for both D1 and D2) should be expected to be similar to the leachable materials, dissolved constituents being the product of the leaching process. The dissolved copper also clearly indicates that physical transport of chemicals through stormwater does not carry material from the Helvetia area to the Santa Cruz River, let alone to the distant Study Reach B area 16.5 miles down the Santa Cruz River. Data for copper concentration through stormwater indicates a lack of physical and chemical connectivity between the Helvetia area and the study Reach B.

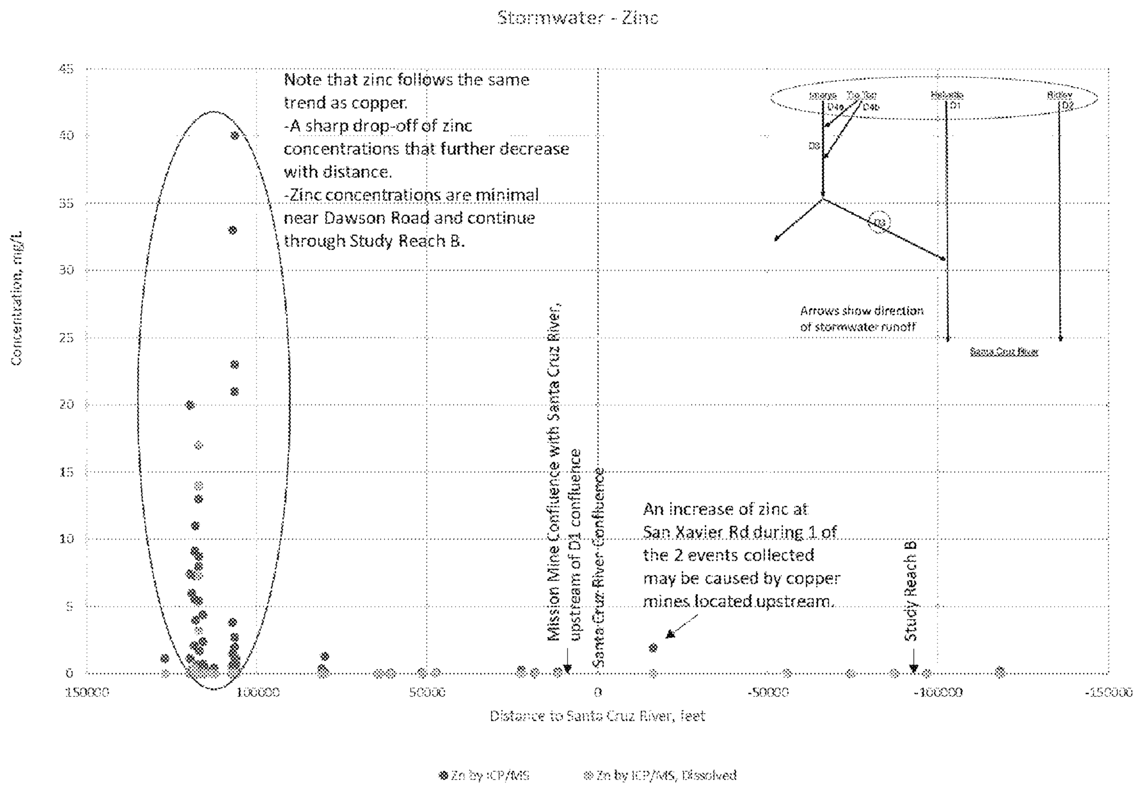



**Figure 16. Total and dissolved zinc in stormwater. Zinc follows the same trend as copper, dropping quickly within a short distance. With multiple storm events captured, there is some variation across events. Despite variation, there are minimal concentrations of zinc at and prior to Study Reach B.**

Very much like the profiles for total and dissolved copper in drainages D1 and D2 (**Figure 15**), total and dissolved zinc display very similar trends (**Figure 16**). Concentrations drop quickly downstream from the source (within 2.5 to 10.4 miles), decreasing further with distance. As human alterations enter the analysis around Dawson Road, there is potential to insert additional sources like railroad bed that is made out of slag, landscaping rock brought in from quarries and mines, and other various chemicals from roadways. As can be seen in Figure 16, there is an increase in zinc during one of the two storm events. Additional sources may include quarries, sand and gravel pits, or 3 copper mines located upstream of this location. Although there are anomalies that display variations from downstream sources, it is clear that stormwater bearing enriched concentrations of chemical elements transported away from the general source area of Helvetia do not themselves represent a source of total or dissolved constituents. Hence, connectivity between the enriched Helvetia source area via physical transport and chemical transport does not appear to be present in the current drainage system.

### 4.2.3 Neutralization of pH

Field measurements of pH were taken during stormwater sampling. Low, acidic pH measurements were observed near the Tip Top Mine very close to the source, quickly dropping before the bottom of the hill on which the Mine is located on the ridge. Neutral pH measurements, approximately a pH of 7, were observed on the east side of Tip Top Mine 380-feet below the source and approximately 1600-feet below the source on the west side of Tip Top Mine (see **Figure 17**). Limestone is present within the surrounding and encapsulating hills of the mine, but further neutralized once the stormwater reacts with the calcium carbonate released by Imerys marble quarry within Drainage 3.

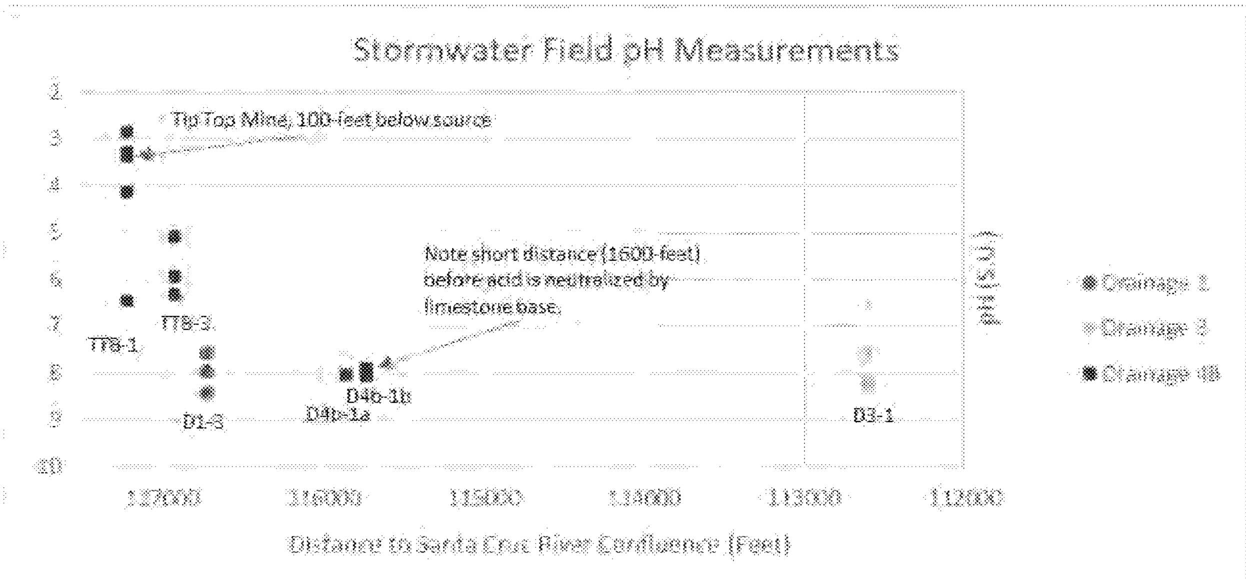



**Figure 17. Stormwater field pH measurements near Tip Top Mine Source. Note the quick neutralization of acid becoming slightly basic with the reaction with calcium carbonate in Drainage 3, below the Imerys marble quarry composed of basic limestone.**

### 4.2.4 Imerys Marble Quarry, Drainage 3

Imerys is a marble quarry that is located at the top of Drainage 3. It is visibly the source of limestone, or calcium carbonate, that is transported downstream through both erosion (Method 3050) and through stormwater transport (Method 1312). Sediment sampling began at D3-1 (see **Figure 18** below for photos), approximately 0.6 mile downstream from the quarry. Initially, the white colors of the limestone occurred across the drainage and formed cemented layers. The compacted layer prevented water infiltration and allowed the stormwater runoff to occur more easily than other drainages in the area.

As samples were collected downstream, the cemented layer became thinner (D3-4A), then absent (D3-4B), but limestone was still abundant within the wash. At the confluence with D1, only limestone precipitate remained but there were contrasting differences from D1. By Dawson Road, no limestone precipitate remained, and colors were similar to surrounding drainages. It was apparent that limestone was carried between 7.4 miles and 9.6 miles. This value is an indicator of how far the stormwater flowed from the Imerys marble quarry. It is also an indicator that stormwater does not flow to the Santa Cruz River.

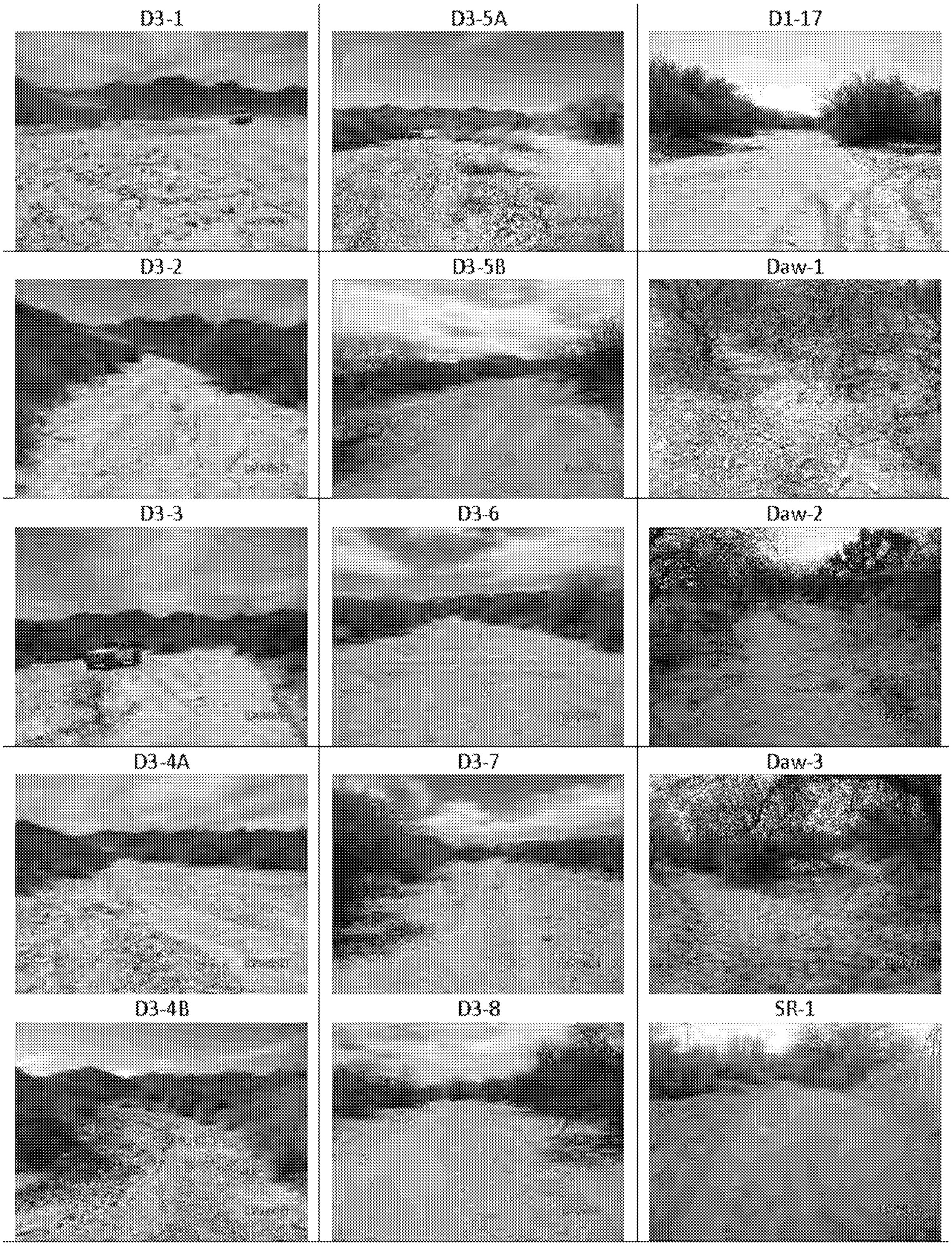



**Figure 18. Limestone tracing in Drainage 3 and Drainage 1.** Note the color differences occurring as a bright white color near the Imerys marble quarry and becoming more tan color further from the source.

A component of calcium carbonate, calcium, was analyzed within the sediment samples by the lab. The calcium content of the sediment samples supports the visual observations as seen above. Calcium drops to below the global mean (36,300 mg/kg) by point D3-8, approximately 6.3 miles downstream of the Imerys marble quarry (see **Figure 19**). Although calcium carbonate precipitate disappears between 7.4 and 9.6 miles, the heavier calcium particles drop by the point. This again indicates that there is no chemical connectivity of calcium between the Helvetia area and Study Reach B.

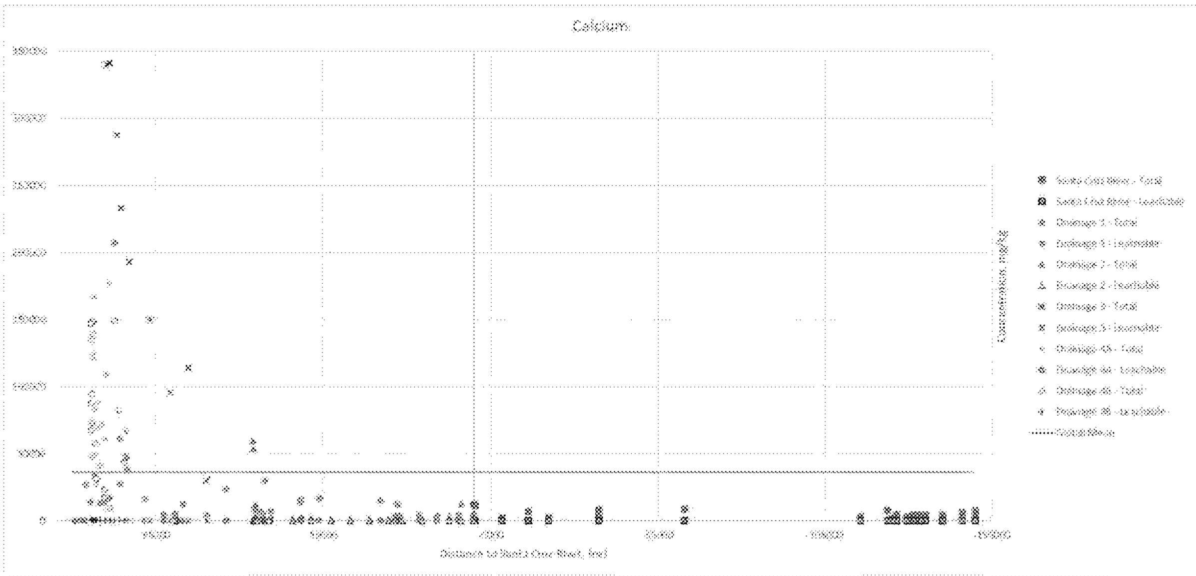


**Figure 19. Calcium concentrations in studied drainages. As seen visually, calcium concentrations drop quickly to below the global mean approximately 6.3 miles below the source (Imerys marble quarry). This demonstrates a lack of calcium chemical connectivity to Study Reach B, another 15.1 miles downstream.**

## 4.3 BIOLOGICAL RESULTS

Biological connectivity refers to the extent to which a drainage supports the capacity to transfer nutrients and organic carbon vital to support downstream food webs in the TNW (e.g. macroinvertebrates present in headwater streams convert carbon in leaf litter making it available to species down streams). Soils under mesquite trees were sampled for organic matter and mesquite trees were tested for chemical absorption to determine the proximity of plants affected by COCs in sediment or water. Biological connections were analyzed using methods seen in Table 2.

Organic matter is a form of a biological passive connection, dependent on water flowing. Ephemeral drainages bordered by continuous vegetation provide xeroriparian habitat and wildlife movement corridors. Drainages also allow the dispersion of seeds through the water or upon wildlife (hitchhiking) moving through the wildlife corridor and thus allow biological connections; the occurrence of a species solely within this habitat may reflect the biological connection. The xeroriparian habitat is also a form of passive biological connection that reflects biological integrity. Invasive species, poor species diversity, and poor hydrological functions threaten biotic integrity and therefore the biological connection. Biological integrity was assessed using rangeland health indicators (BLM 2005) from the Helvetia drainage down to the confluence with the Santa Cruz River.

**Table 2. Biological Connection Analysis.**

| Biological Connection Analysis | Method | Result |
|---|---|---|
| Biotic Integrity<br>Continuous vegetation lining the drainage | Rangeland Health Indicators (BLM, 2005)<br>Satellite Imagery, field reconnaissance | Poor biotic integrity as a result of poor hydrologic function<br>Discontinuous vegetation lining the drainage |
| Organic Matter | Combustion, lab analysis | Low amounts of organic matter (averaging 2.7%) |
| Phytoextraction | EPA Method 3050 (total concentration), lab analysis | Affects of chemicals within sediment and water on plants does not travel further than 17.4 miles from Project site |

As described in section B.5.5.3 (EPA 2015), the ephemeral drainages within the study area begin with naturally made drainages near the Project site that are typically lined with woody vegetation that compose a xeroriparian habitat. This habitat was observed along drainages in the Helvetia area down to Sahuarita Road. Woody vegetation consisted of mesquites (*Prosopis velutina*), desert hackberry (*Celtis pallida)*, catclaw acacia (*Acacia greggii*), desert broom (*Baccaris sarathroiodes*), and occasionally netleaf hackberry (*Celtis reticulata*). Perennial grasses and perennial forbs grow on the margins of the channels.

As can be seen on satellite imagery (**Figures 20 – 22** below) the biological integrity of the xeroriparian habitat degrades north of Sahuarita Road down to the confluence of the Santa Cruz River. The artificially created drainage, beginning just prior to Dawson Road and continues to the confluence with the Santa Cruz River, is low in biodiversity and vegetation cover and displays large amounts of bare ground. Vegetation along the channel consists of scattered mesquite trees (*Prosopis velutina*), desert broom (*Baccaris sarathroiodes*), invasive bermuda grass (*Cynodon dactyla*). During the 2021 monsoon season, sufficient precipitation allowed for the growth of annual forbs (primarily pigweed, *Amaranthus palmeri*). Beginning near a sand and gravel quarry, the channel becomes deeper and erosional features begin to form along the margins of the channel. Just downstream of the Nogales Highway crossing, the channel deepens further and the banks of the wash consist of highly eroded alluvium. This trend continues to the confluence with the Santa Cruz River, becoming increasingly deeper with larger amounts of soil loss and instability. See **Figures 20 to 22** below for a comparison of portions of Drainage 1.

**Figure 20. Lower Drainage 1. Note the lack of vegetation and large amounts of bare ground. Erosional features are apparent with satellite imagery. This is indicative of a geologically recent path.**

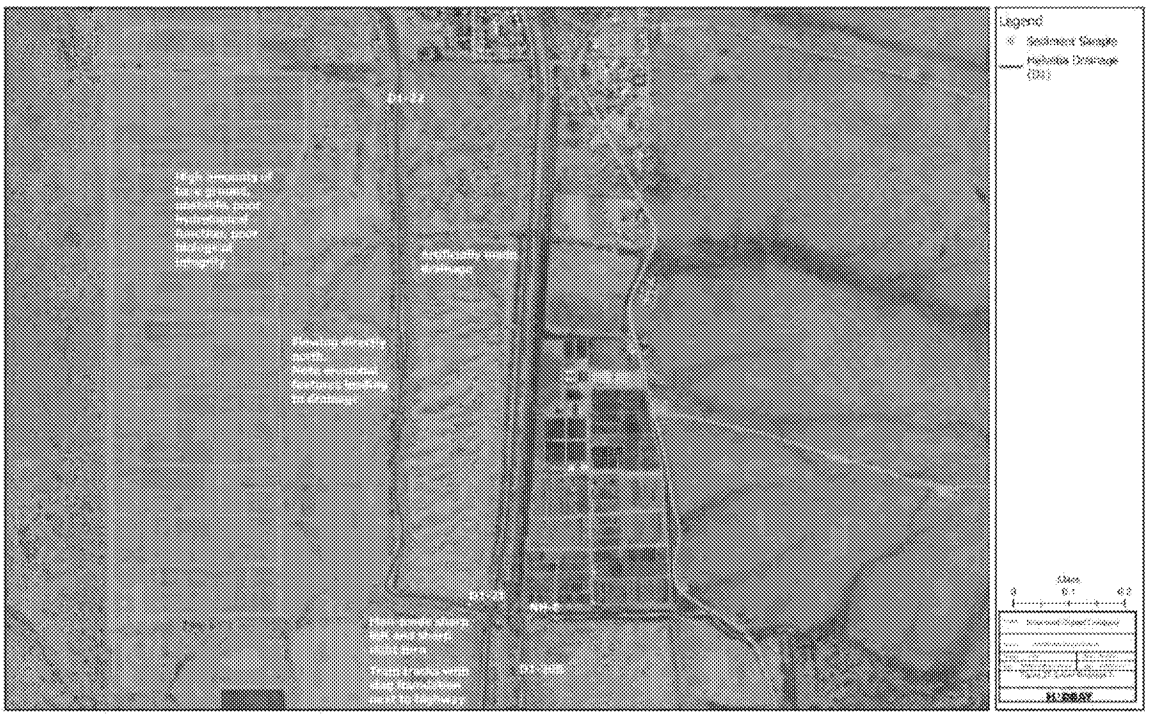


**Figure 21. Lower Drainage 1 near Nogales Highway. Note the lack of vegetation and large amounts of bare ground. Erosional features are apparent with satellite imagery. Man-made features of an artificially directly drainage can be observed.**

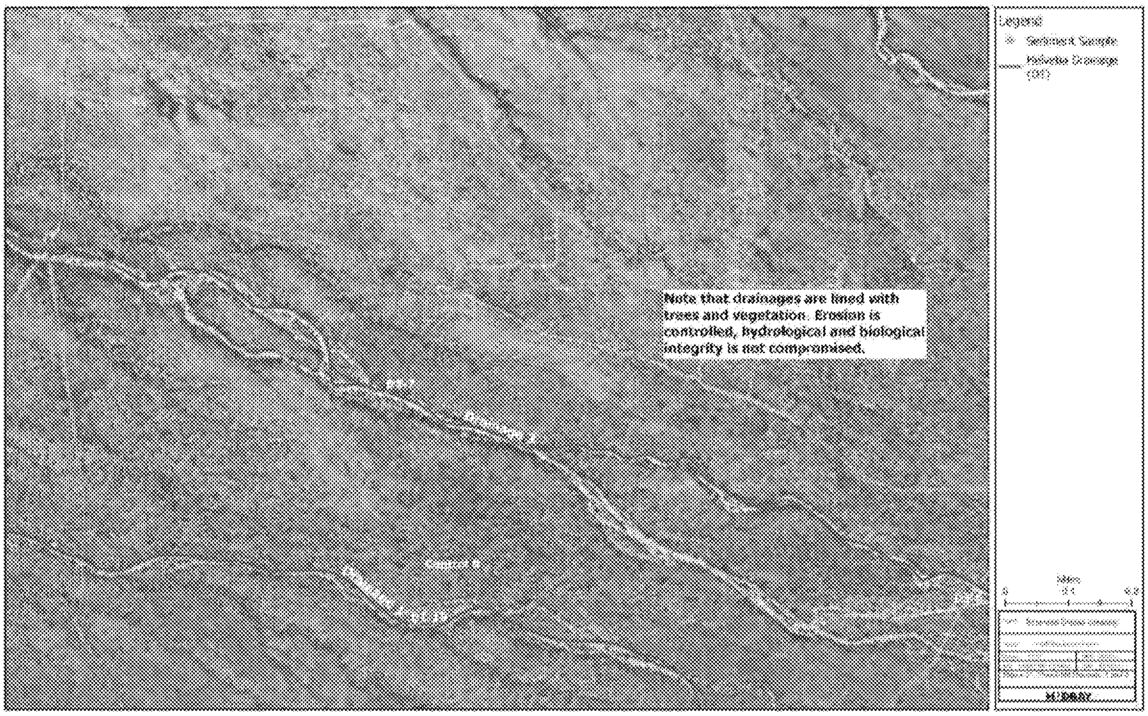



**Figure 22. Drainages 1 and 3, tree and shrub lined washes. Note the differences between Figures 20 and 21. Washes are lined with trees and shrubs. A lack of erosional features indicate that hydrological and biological integrity are intact.**

Rangeland indicators (BLM 2005) results show that the drainage north of the quarry located east of Nogales Highway are highly unstable and hydrological and biological functions are hindered. Hydrologic functions are defined as the "capacity of an area to capture, store, and safely release water from rainfall, run-on, and snowmelt (where relevant), to resist a reduction in this capacity to recover this capacity when a reduction does occur" (BLM 2005). The loss of large amounts of soil through gullies, rills, lack of erosion resistance, high amounts of bare ground (during most of the year), depositional areas, water flow patterns, low amounts of litter, disproportionate plant functional groups, and the presence of large amounts of invasive species all indicate that the site stability, hydrological functions, and biological integrity are poor and severely compromised.

As can be seen in satellite or aerial imagery, trees and xeroriparian habitat do not continuously line the ephemeral drainage that flows episodically from the Helvetia area. The lack of biotic integrity, site and soil stability, and hydrologic function indicate that the Helvetia drainage is not biologically connected to downstream aquatic resources.

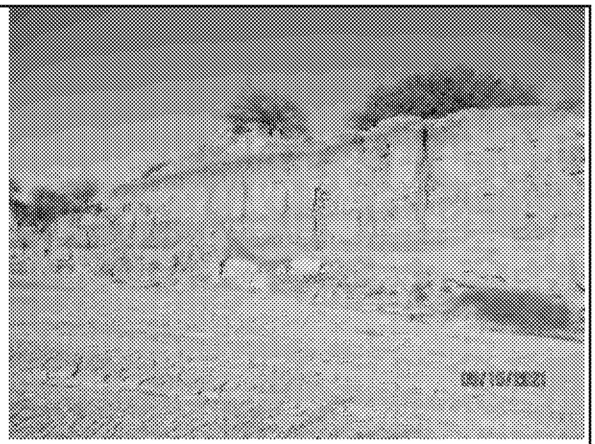
| | |
|---|---|
|  |  |
| Sediment Point D3-7. Ephemeral washes are lined with trees and shrubs. This stable site shows that hydrological and biological functions are not compromised. | Point SCR-0, Santa Cruz River confluence. Large erosional features on the banks (high walls, gullies, rills). Artificial berms controlling surface flow from surrounding areas drop into the river on the left. |

**Figure 23. Photos contrasting erosional features. These photos demonstrate a stable site with good hydrological function and biotic integrity as compared to an unstable site with relatively poor hydrological function and biotic integrity. The loss of soil creates a negative feedback loop that hinder infiltration, availability of nutrients and organic matter, promotes invasive species and decreases biodiversity.**

Organic matter below the mesquite tree was collected and analyzed by the lab. Results show that organic matter contribution was low with a maximum of 7.8%, a mean of 2.7%, and a median of 2.5% organic matter. Total carbon and total inorganic carbon results show very similar trends as can be seen in **Attachment D**. Additionally, there is no trend from a high organic matter content to low content to demonstrate a transportation of organic matter to aquatic resources downstream. There must be a significant nexus to the downstream TNW to display biological connectivity. The low amounts of organic matter should be expected with poor biotic integrity as described above. A mean of 2.7% organic matter does not constitute a significant contribution to downstream organic matter and therefore not likely to contribute a significant amount of nutrients to downstream aquatic resources.

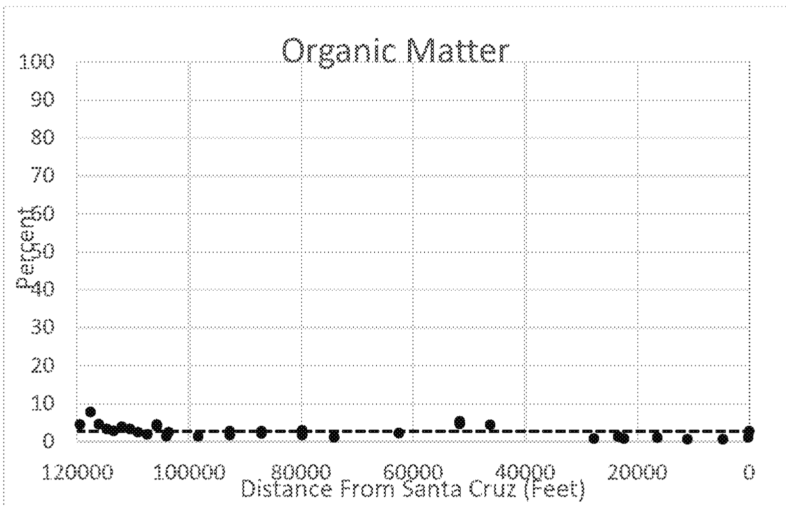
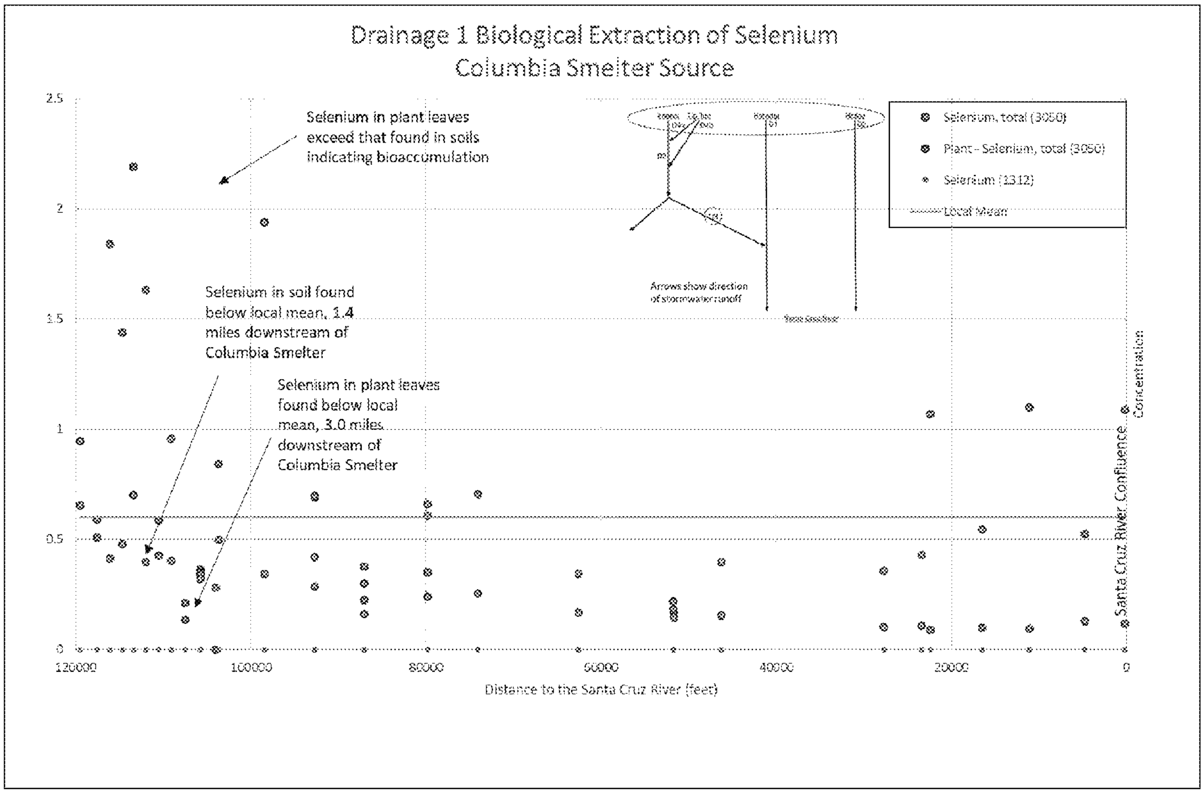



**Figure 24. Organic matter contribution to downstream aquatic resources is relatively low. The dashed line is the mean organic matter concentration. No significant trends were observed, low concentrations of organic matter are present throughout Drainage 1 and are not being transported from the Helvetia area to the Santa Cruz River or Study Reach B.**

Mesquite trees were selected to study as they occurred from the Helvetia area down to the Santa Cruz River. Although the species generally occurs along the drainages, it is not specific to the drainage as it occurs on the uplands and somewhat ubiquitously across the landscape. There were no species observed that provided a biological link to Study Reach B.

Phytoextraction provides a link between chemical and biological connectivity and provides a natural extraction of chemicals. Mesquite trees removed chemicals that include zinc, molybdenum, and selenium. A similar study conducted by the USGS (1980) analyzed molybdenum extracted by mesquite trees. The study states that molybdenum is taken up by mesquite from groundwater rather than from the flow of the drainages. Also, molybdenum is soluble (as opposed to copper) and can travel farther than copper from the ore deposit. Since there are many mines within the Santa Rita and Sierrita Mountains and the area is known for molybdenum deposits, it is not a unique tracer (signature) of the Helvetia area to indicate travel distance. Molybdenum was used as a proxy to find new mineral deposits as it occurs naturally at elevated levels in the aquifer at greater distances than copper. Due to these determinations, molybdenum was disqualified from the current study.

Phytoextraction of selenium and zinc can be observed in **Figure 25**, following similar trends to that seen in total selenium and zinc within sediments. It appears that a significant amount of selenium and zinc is being extracted from the soil (sediment) as concentrations are greater in the trees at times than within the soil, though for zinc the trend was observed at lower soil concentration levels beginning at approximately 17.4 miles from Helvetia. The excess of selenium and zinc within the plant as compared to the soil suggests that it may be accumulating in the tree (bioaccumulation).



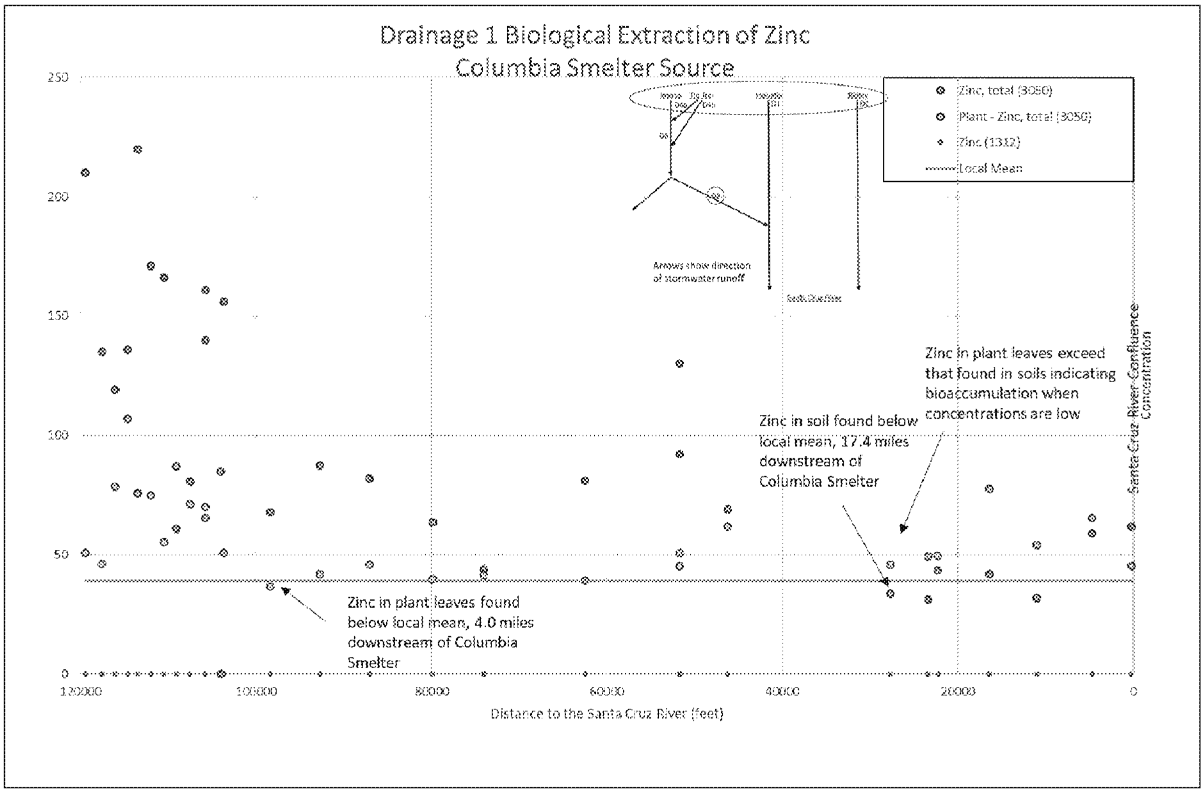



**Figure 25. Selenium and zinc extraction by plants in Drainage 1. Plants extract selenium and zinc from the soil and display similar trends as soil, decreasing quickly initially and decreasing until no chemical was detected in either the plants or the soils prior to the Santa Cruz River confluence. Plant concentration of selenium drop below the local standard by 3.0 miles from the source and 4.0 miles for zinc.**

Although the concentrations may at times be greater in the tree than within the soil, selenium and zinc follows similar trends as seen in the sediment and stormwater samples, decreasing in concentration with distance. A complete set of biological graphs can be found in **Attachment E**. A plant sample photo log can be found in **Attachment F**.

The decreasing total concentrations of zinc, and selenium indicate that plants bearing enriched concentrations of chemical elements are only affected within the general source area of Helvetia, does not affect plant growth, and there is a lack of connectivity between the Helvetia area and the Santa Cruz River. Elevated concentrations of these elements dropped to background levels within 4.0 miles of the Helvetia area and there is no indication of elevated metals for the remaining 18.7miles downstream to the Santa Cruz intersection within the ephemeral drainage.

The combination of these complementary biological studies show that plant uptake of available contaminants does not persist beyond 4.0 miles from the Helvetia site, the soil is devoid of organic material that is not likely to contribute beneficially to aquatic or plant species downstream, and discontinuous vegetation contributing to poor biotic integrity concludes that there is no biological connection to the Santa Cruz River let alone Study Reach B located 16.5 miles further downstream of the Santa Cruz River confluence.

# 5.0 CONCLUSION

The drainages from the Ridley Mine, Tip Top Mine, and Columbia Smelter locations release contaminants to local drainages. While there is a path for water to flow, chemical measurements were used to determine physical connectivity. All measurable chemical tracers within stormwater and sediment samples indicate that the water originating at site and the chemicals carried through the water travels no further than 17.4 miles from the Helvetia area. Therefore, there is not a physical or chemical connection to the Santa Cruz River or Study Reach B. The lack of continuous vegetation, poor biotic integrity, low contribution of organic matter, and phytoextraction of chemicals within plants traveling no further than 4.0 miles from the Helvetia site demonstrate that there is no biological connection to the Santa Cruz River or Study Reach B located another 16.5 miles downstream.

# 6.0 REFERENCES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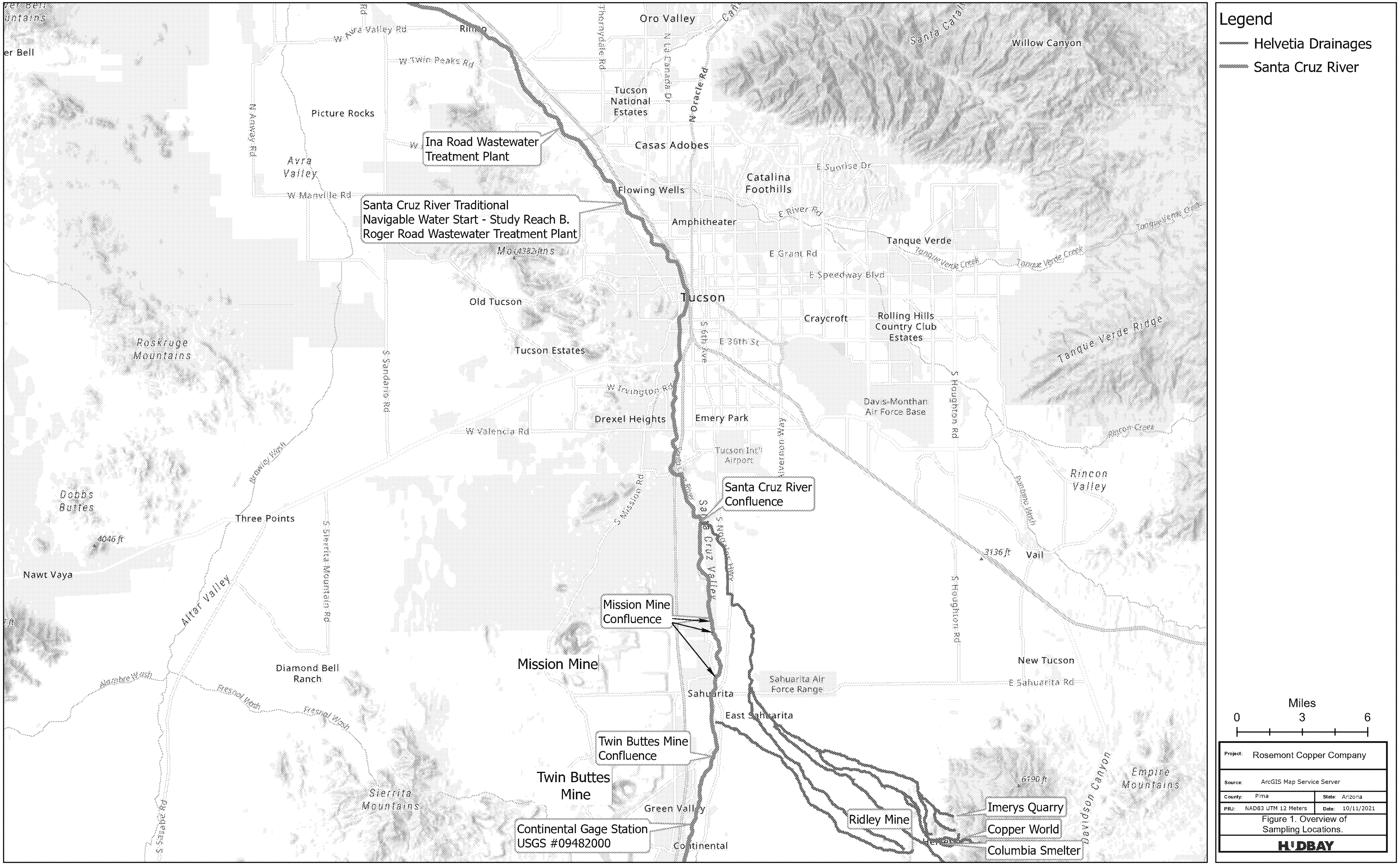
# FIGURES


Legend
Helvetia Drainages
Santa Cruz River
Ina Road Wastewater Treatment Plant
Santa Cruz River Traditional Navigable Water Start - Study Reach B. Roger Road Wastewater Treatment Plant
Santa Cruz River Confluence
Mission Mine Confluence
Mission Mine
Twin Buttes Mine Confluence
Twin Buttes Mine
Continental Gage Station USGS #09482000
Ridley Mine
Imerys Quarry
Copper World
Columbia Smelter
Oro Valley
Tucson National Estates
Casas Adobes
Catalina Foothills
Flowing Wells
Amphitheater
Tanque Verde
Tucson
Craycroft
Rolling Hills Country Club Estates
Picture Rocks
Avra Valley
Old Tucson
Tucson Estates
Roskruge Mountains
Drexel Heights
Emery Park
Davis-Monthan Air Force Base
Tucson Int'l Airport
Rincon Valley
Dobbs Buttes
Three Points
Nawt Vaya
Altar Valley
Vail
New Tucson
Diamond Bell Ranch
Sahuarita
Sahuarita Air Force Range
East Sahuarita
Sierrita Mountains
Green Valley
Continental
Empire Mountains
Davidson Canyon
Willow Canyon
Tanque Verde Ridge
Miles
0 3 6
Project: Rosemont Copper Company
Source: ArcGIS Map Service Server
County: Pima
State: Arizona
PRJ: NAD83 UTM 12 Meters
Date: 10/11/2021
Figure 1. Overview of Sampling Locations.
HUDBAY


Summit
SANTA CRUZ VALLEY
S Nogales Hwy
Drainage 1
S Mission Rd
Mission Rd
W Helmet Peak Rd
2969 ft
Sahuarita
E Sahuarita Rd
W Sahuarita Rd
S Houghton Rd
East Sahuarita
D1
Duval
S La Canada Dr
Drainage 1
Drainage 1
Drainage 3
Twin Buttes
SANTA CRUZ VALLEY
S Old Nogales Hwy
W Duval Mine Rd
Green Valley
Continental
Drainage 2
Ridley Mine
D4B
D4A
D3
D3
Imerys Marble Quarry
Tip Top Mine
Helvetia
Columbia Smelter
SYCAMORE CA
Legend
Drainage
Santa Cruz River
Miles
0
1
3
Project: Rosemont Copper Company
Source: ArcGIS Map Service Server
County: Pima
State: Arizona
PRJ: NAD83 UTM 12 Meters
Date: 10/22/2021
Figure 2. Drainage Locations.
HUDBAY

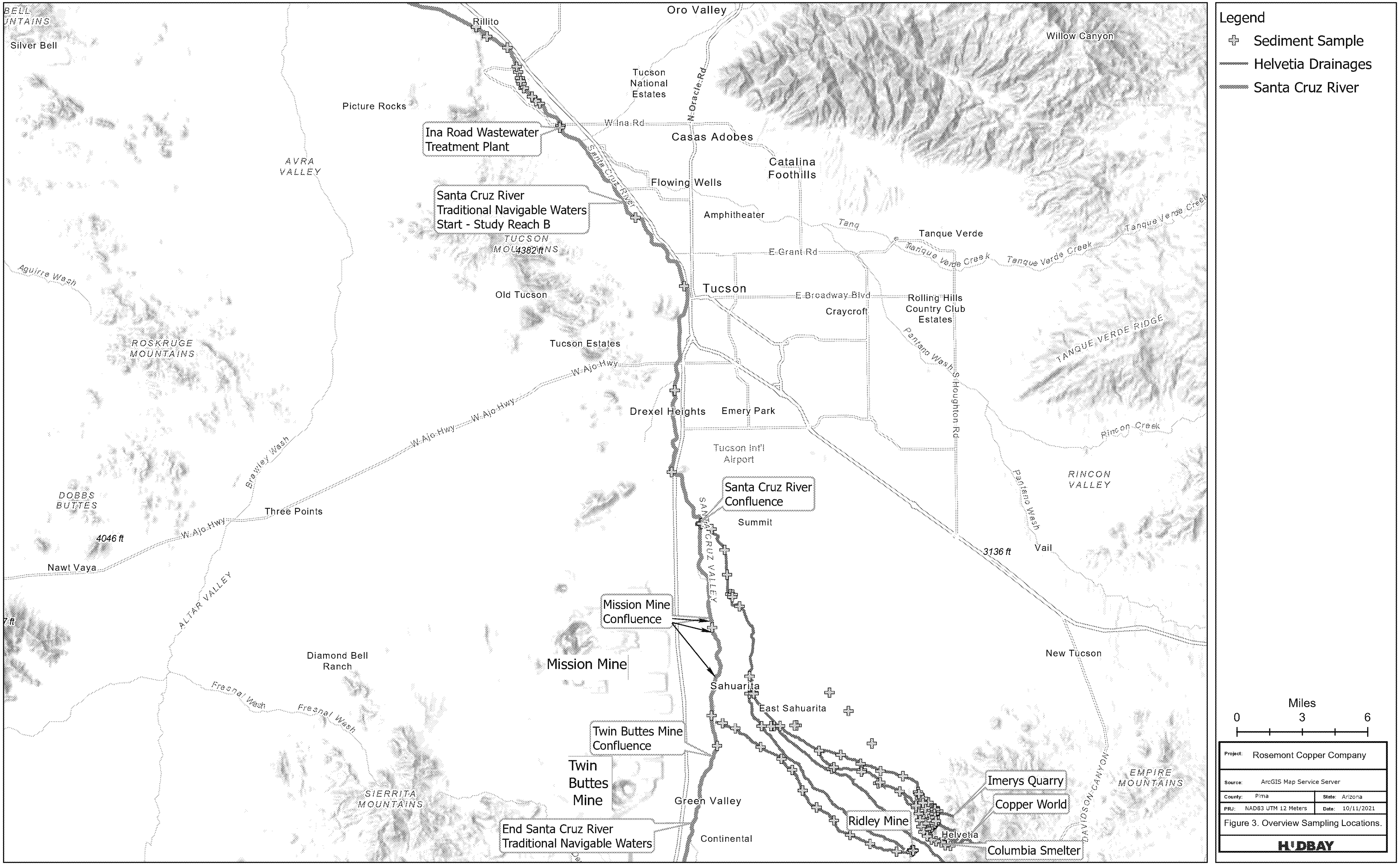


Figure 3. Overview Sampling Locations.

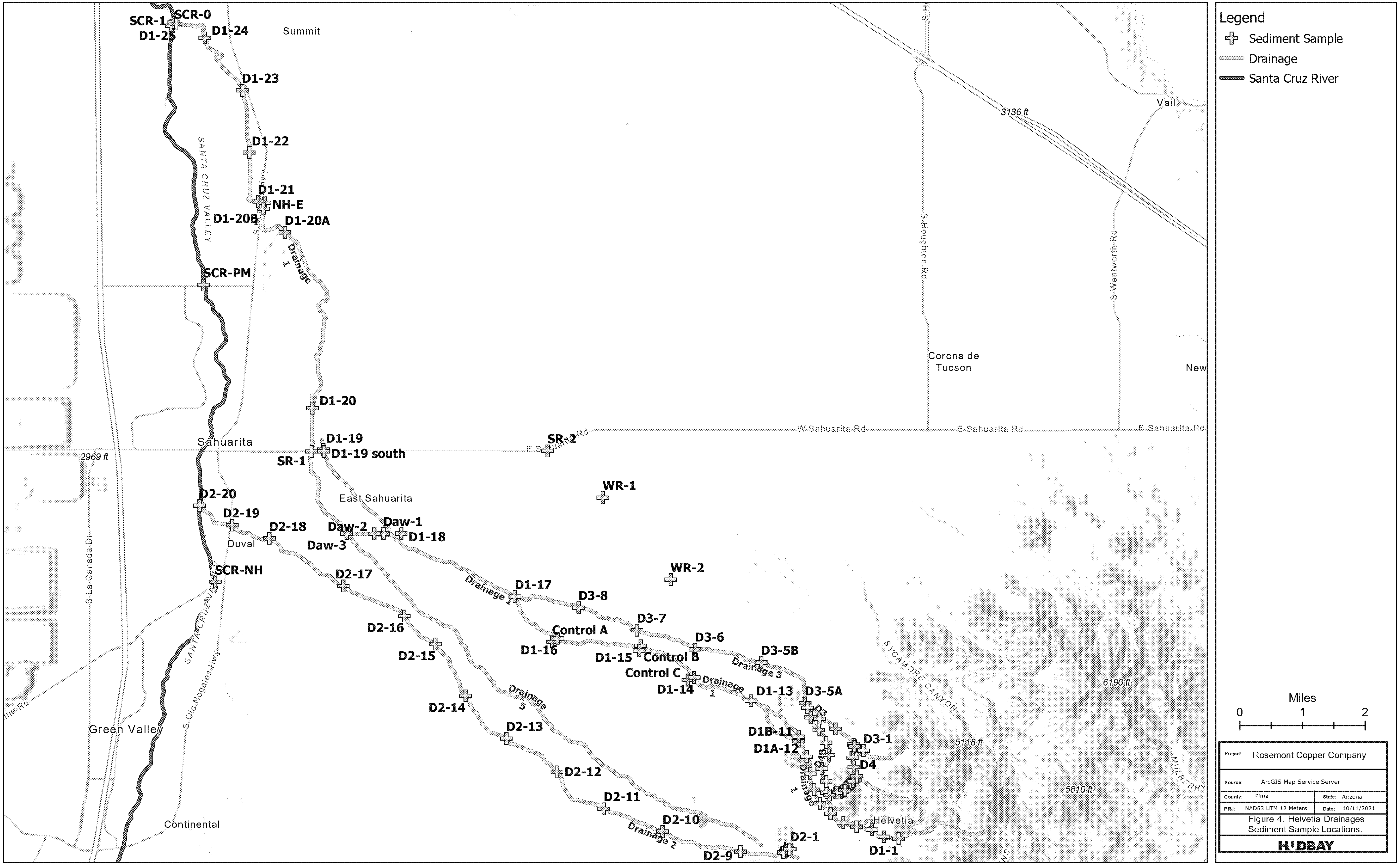
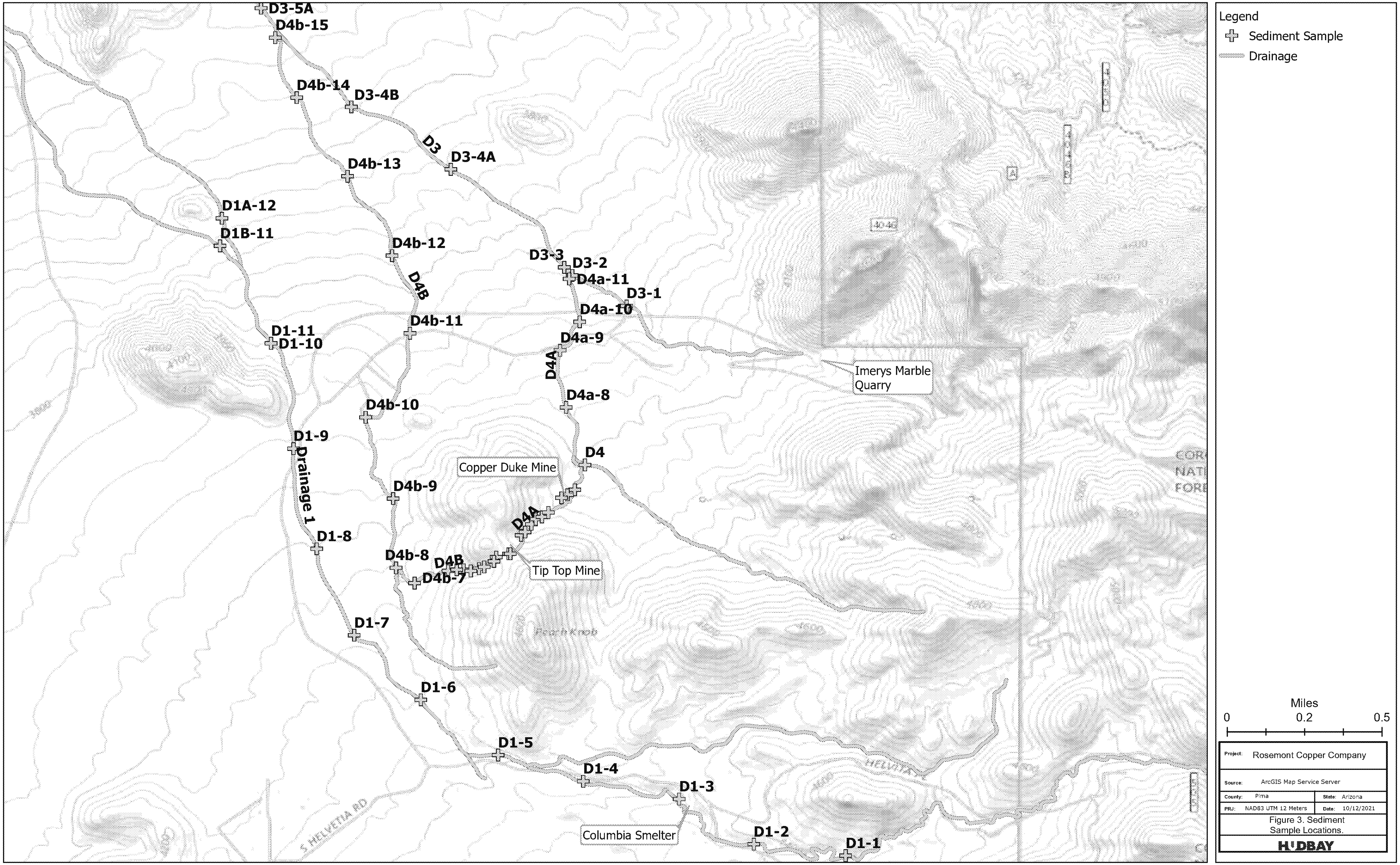
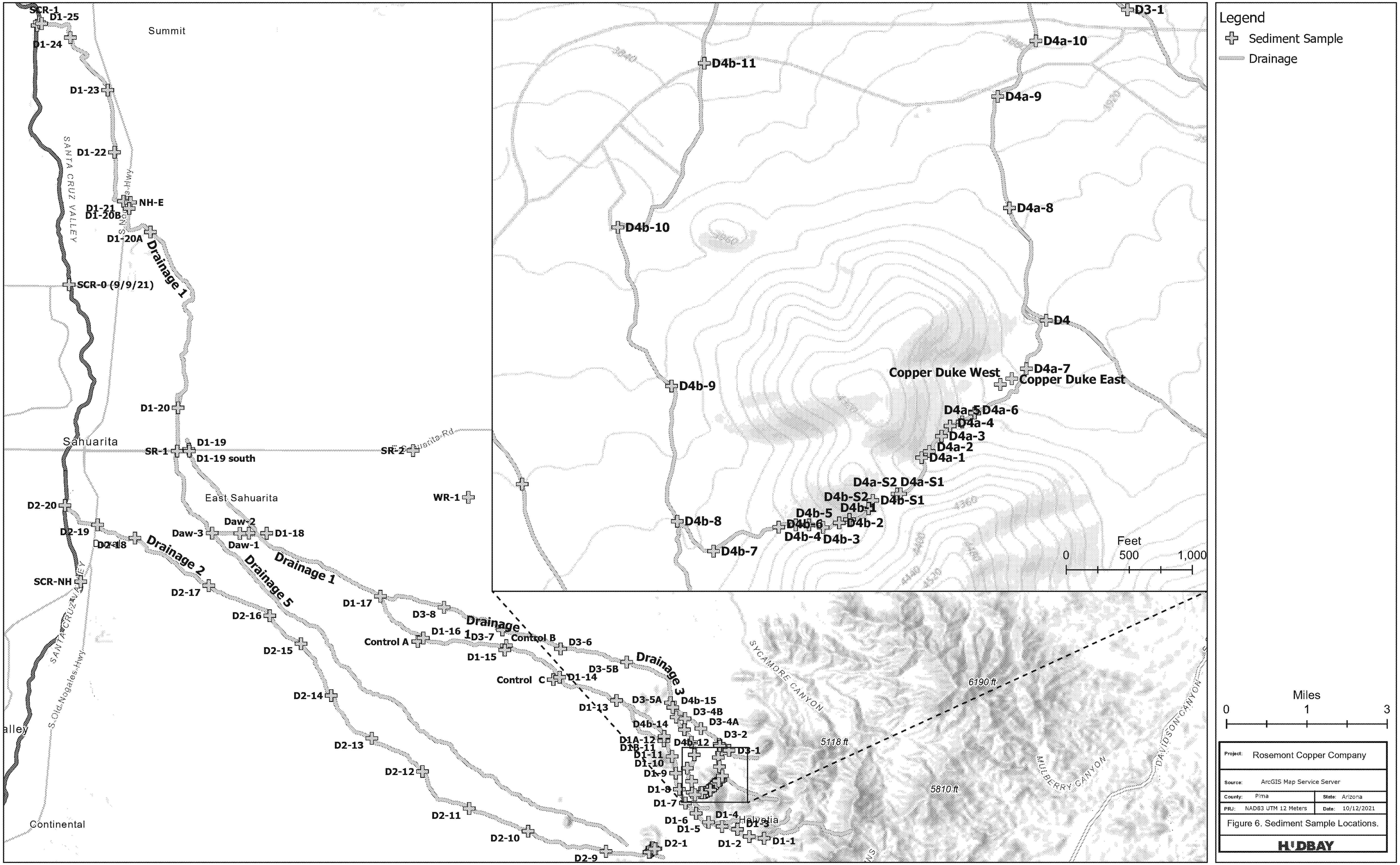



Figure 4. Helvetia Drainages Sediment Sample Locations.


Legend
Sediment Sample
Drainage
D3-5A
D4b-15
D4b-14
D3-4B
D3
D3-4A
D4b-13
D1A-12
D1B-11
D4b-12
D3-3
D3-2
D4a-11
D3-1
D4B
D4a-10
D4b-11
D1-11
D1-10
D4a-9
D4A
Imerys Marble Quarry
D4a-8
D4b-10
D1-9
D4
Copper Duke Mine
Drainage 1
D4b-9
D4A
D1-8
D4b-8
D4B
D4b-7
Tip Top Mine
D1-7
Peach Knob
D1-6
D1-5
D1-4
D1-3
HELVETIA
S HELVETIA RD
Columbia Smelter
D1-2
D1-1
Miles
0 0.2 0.5
Project: Rosemont Copper Company
Source: ArcGIS Map Service Server
County: Pima
State: Arizona
PRJ: NAD83 UTM 12 Meters
Date: 10/12/2021
Figure 3. Sediment Sample Locations.
HUDBAY



Legend
Sediment Sample
Drainage
Summit
Sahuarita
East Sahuarita
Continental
Helvetia
Drainage 1
Drainage 2
Drainage 3
Drainage 5
Copper Duke West
Copper Duke East
SYCAMORE CANYON
MULBERRY CANYON
DAVIDSON CANYON
SANTA CRUZ VALLEY
6190 ft
5118 ft
5810 ft
Feet
0 500 1,000
Miles
0 1 3
Project: Rosemont Copper Company
Source: ArcGIS Map Service Server
County: Pima
State: Arizona
PRJ: NAD83 UTM 12 Meters
Date: 10/12/2021
Figure 6. Sediment Sample Locations.
HUDBAY

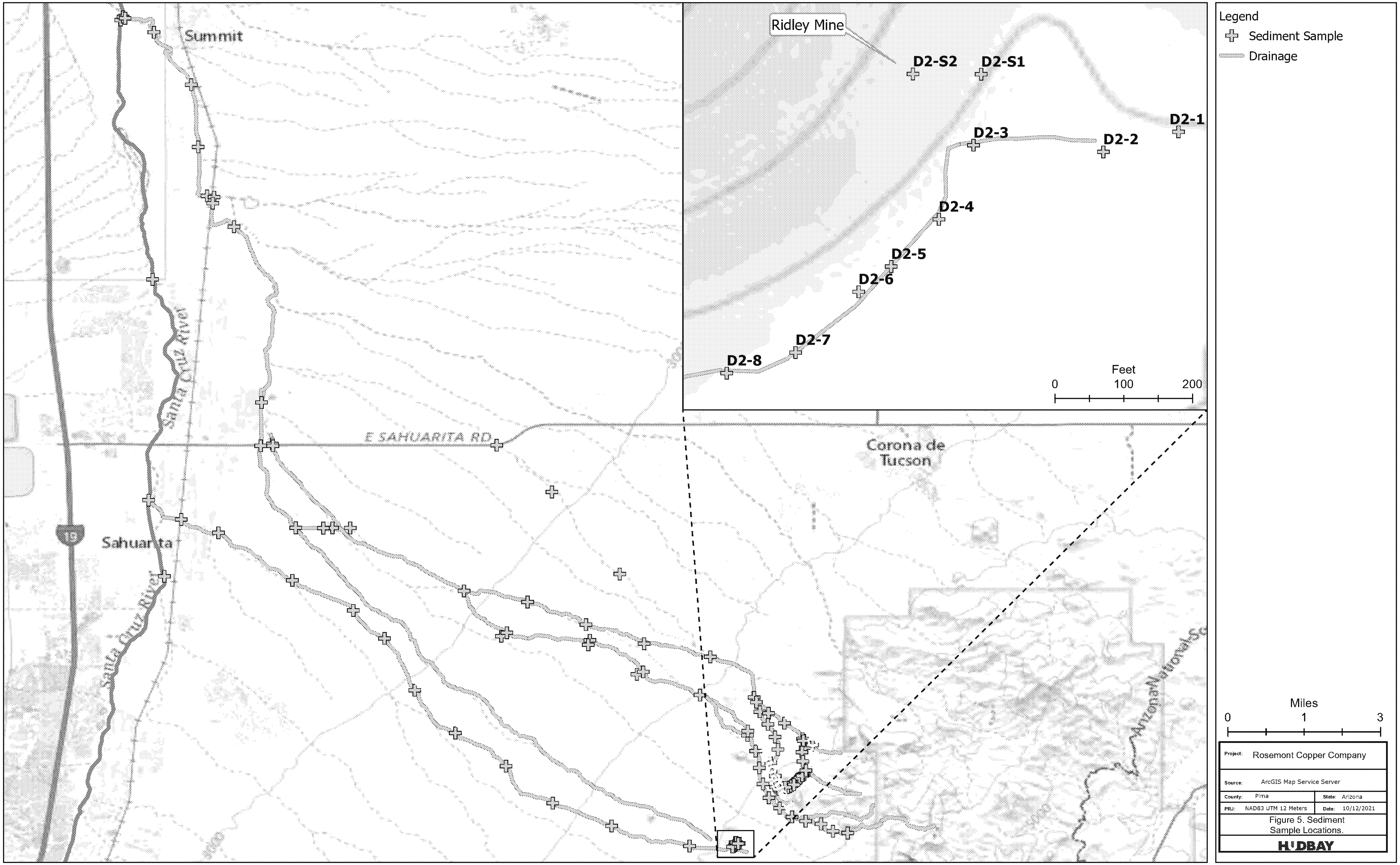
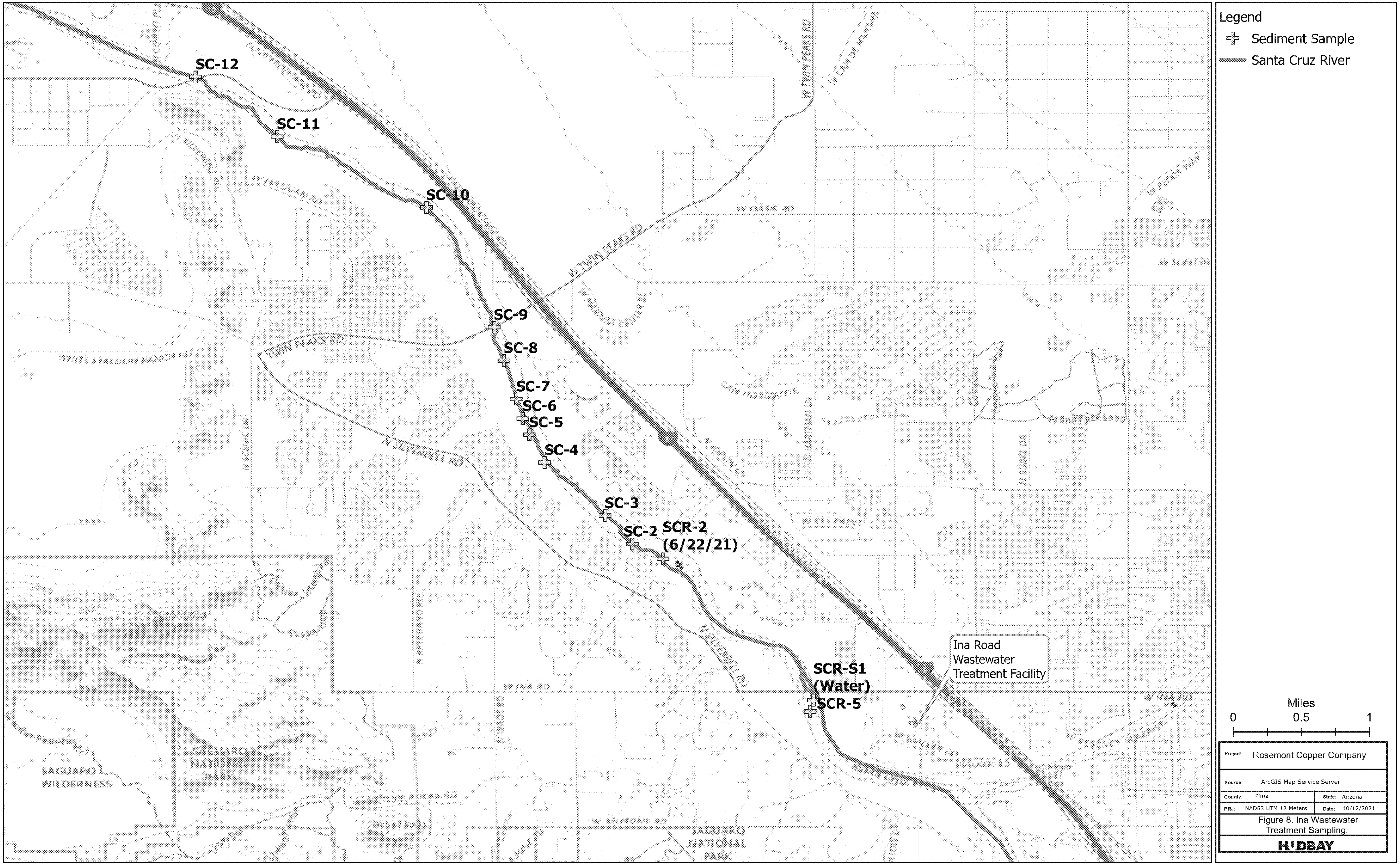
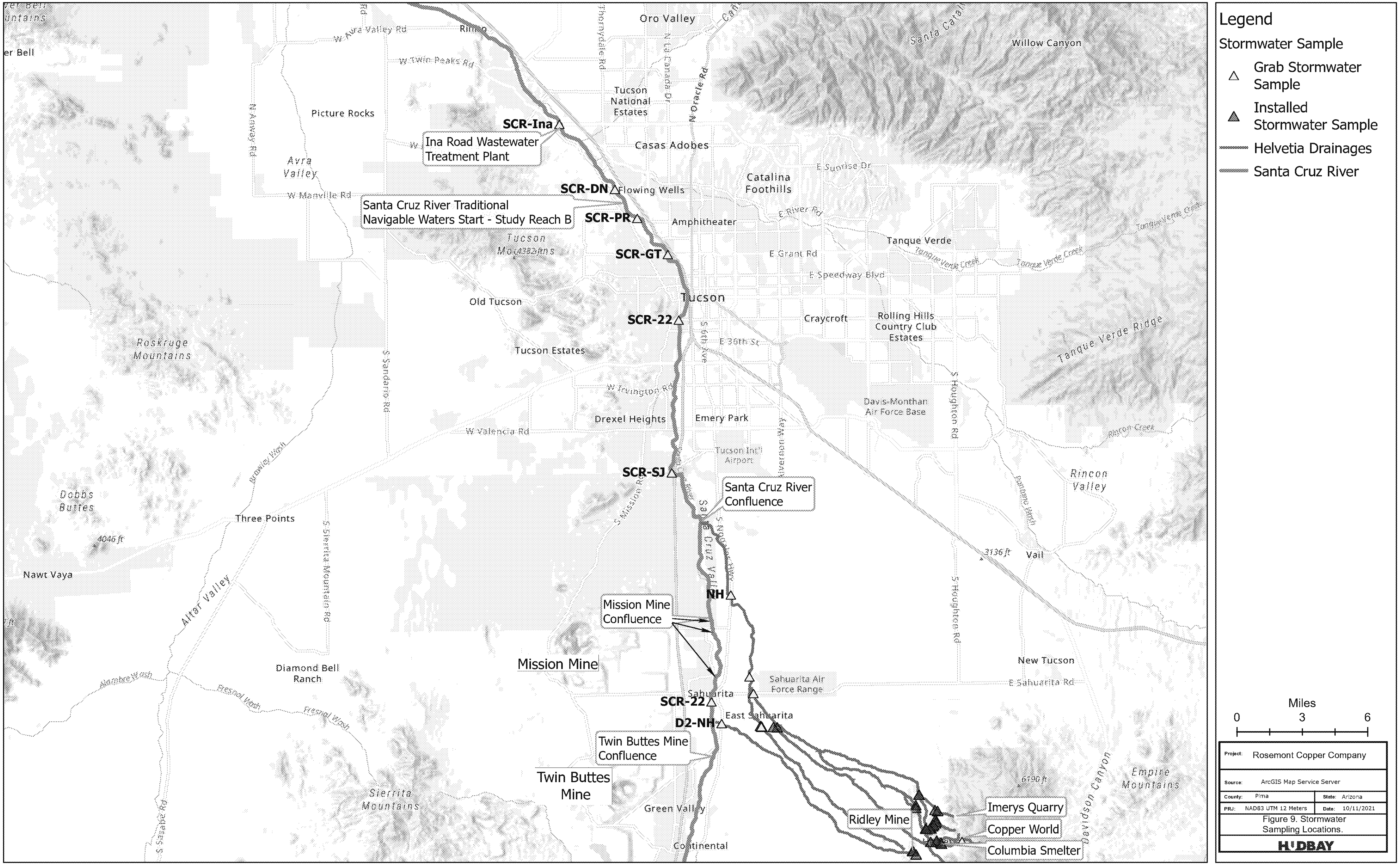



Figure 5. Sediment Sample Locations.



SC-12
SC-11
SC-10
SC-9
SC-8
SC-7
SC-6
SC-5
SC-4
SC-3
SC-2
SCR-2
(6/22/21)
SCR-S1
(Water)
SCR-5
Ina Road
Wastewater
Treatment Facility
W OASIS RD
W TWIN PEAKS RD
TWIN PEAKS RD
WHITE STALLION RANCH RD
W MILLIGAN RD
N SILVERBELL RD
CAM HORIZANTE
N HARTMAN LN
W INA RD
W WALKER RD
W BELMONT RD
SAGUARO NATIONAL PARK
SAGUARO WILDERNESS
N SCENIC DR
N WADE RD
N ARTESIANO RD
W SUMTER
W PECOS WAY
Legend
Sediment Sample
Santa Cruz River
Miles
0
0.5
1
Project: Rosemont Copper Company
Source: ArcGIS Map Service Server
County: Pima
State: Arizona
PRJ: NAD83 UTM 12 Meters
Date: 10/12/2021
Figure 8. Ina Wastewater Treatment Sampling.
HUDBAY


Legend
Stormwater Sample
Grab Stormwater Sample
Installed Stormwater Sample
Helvetia Drainages
Santa Cruz River
SCR-Ina
Ina Road Wastewater Treatment Plant
SCR-DN
Santa Cruz River Traditional Navigable Waters Start - Study Reach B
SCR-PR
SCR-GT
SCR-22
SCR-SJ
Santa Cruz River Confluence
NH
Mission Mine Confluence
Mission Mine
SCR-22
D2-NH
Twin Buttes Mine Confluence
Twin Buttes Mine
Ridley Mine
Imerys Quarry
Copper World
Columbia Smelter
Tucson
Oro Valley
Picture Rocks
Casas Adobes
Catalina Foothills
Flowing Wells
Amphitheater
Tanque Verde
Old Tucson
Tucson Estates
Craycroft
Rolling Hills Country Club Estates
Drexel Heights
Emery Park
Davis-Monthan Air Force Base
Tucson Int'l Airport
Three Points
Nawt Vaya
Diamond Bell Ranch
Sahuarita
East Sahuarita
Sahuarita Air Force Range
Green Valley
Continental
New Tucson
Vail
Rincon Valley
Roskruge Mountains
Sierrita Mountains
Empire Mountains
Tanque Verde Ridge
Willow Canyon
Miles
0
3
6
Project: Rosemont Copper Company
Source: ArcGIS Map Service Server
County: Pima
State: Arizona
PRJ: NAD83 UTM 12 Meters
Date: 10/11/2021
Figure 9. Stormwater Sampling Locations.
HUDBAY

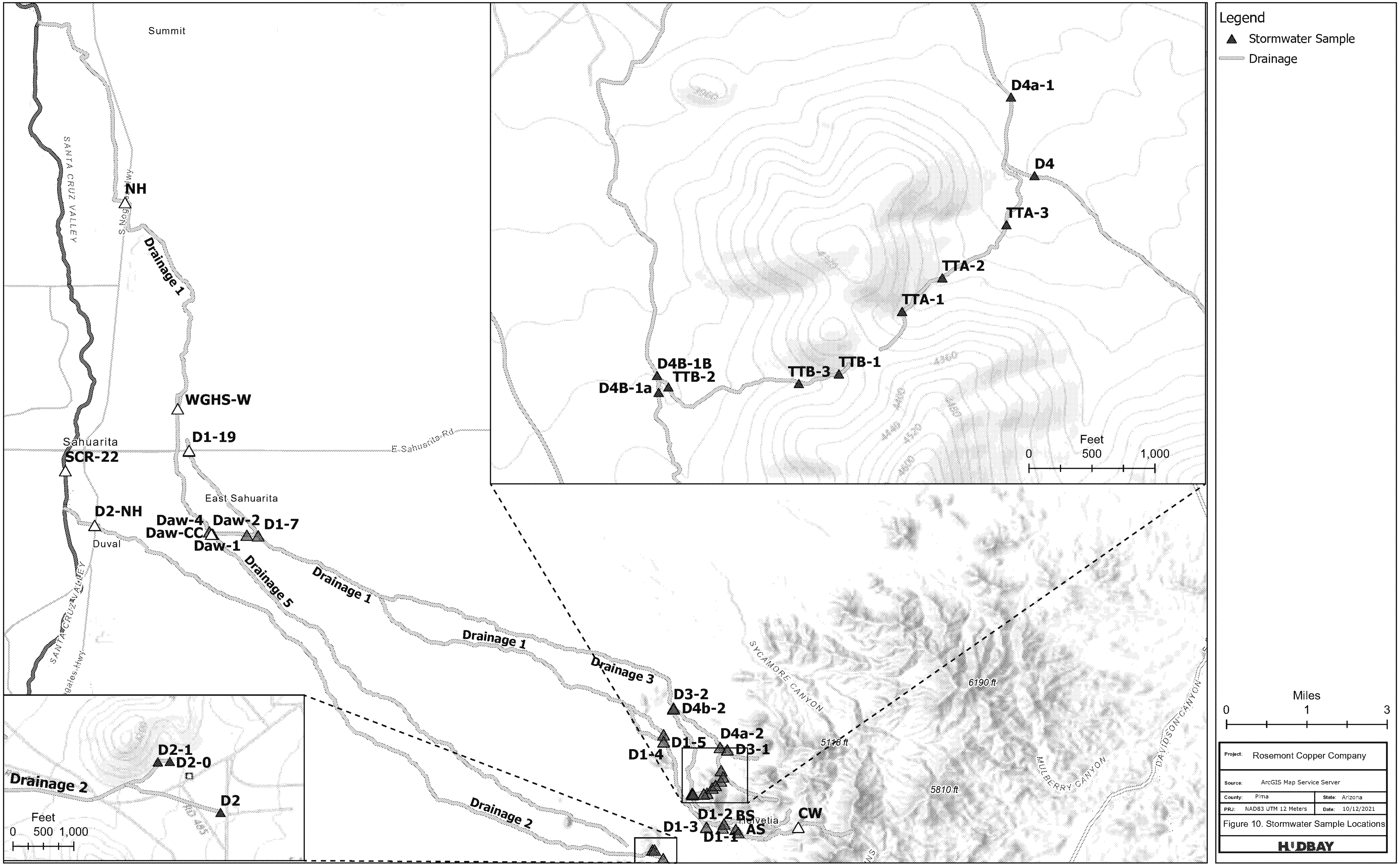


Figure 10. Stormwater Sample Locations

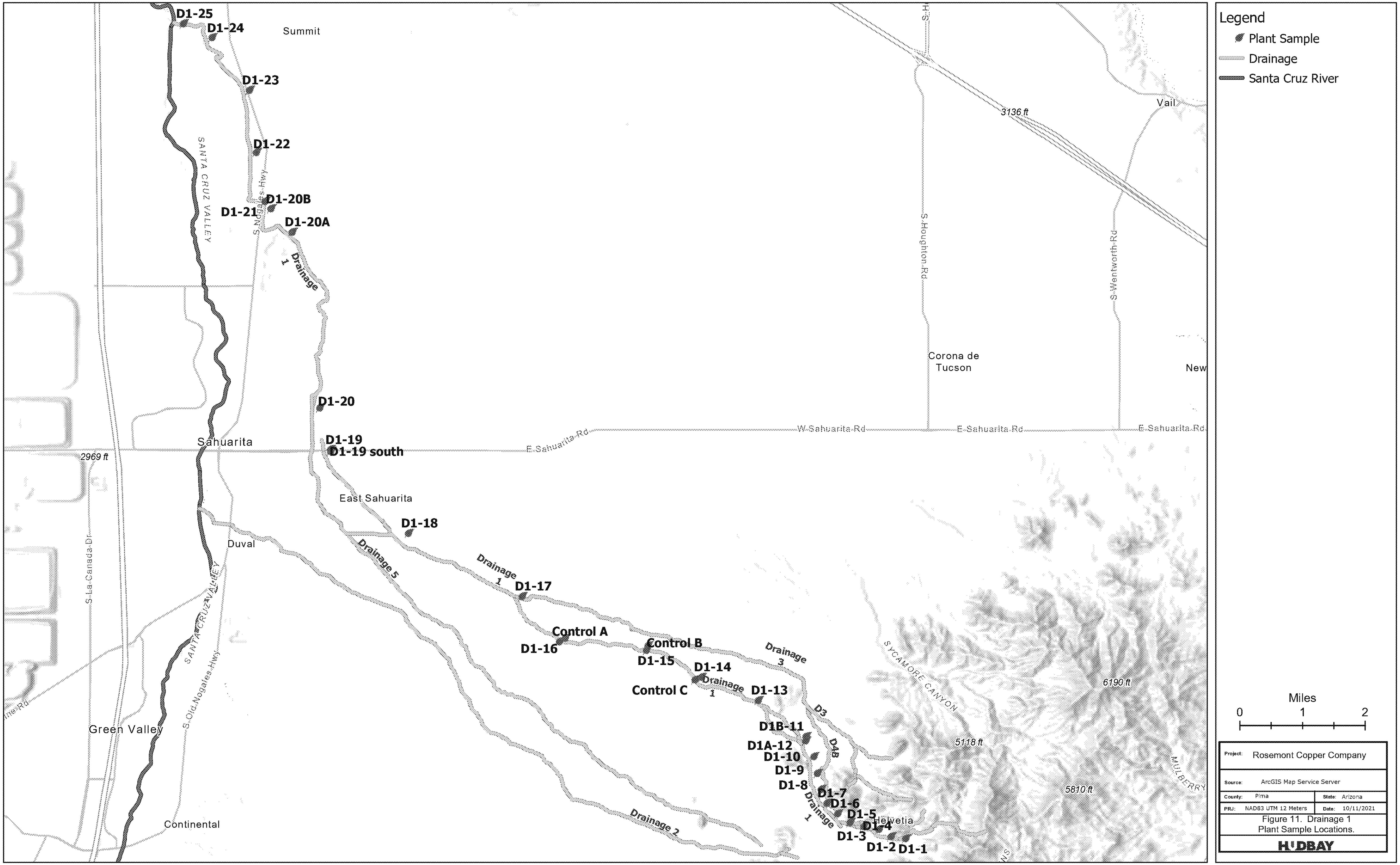



Figure 11. Drainage 1 Plant Sample Locations.

# ATTACHMENT A

*404 Connectivity Sampling Analysis Plan* (Hudbay, 2021)

# *404 Connectivity*
# *Sampling and Analysis Plan*
# *Rosemont Copper Company*
# *West Side Properties*

HUDBAY

**June 2021**

# 1. BACKGROUND

Under the 2008 Rapanos guidance, an ephemeral wash could only be considered a water of the U.S. (WOTUS) if it could be demonstrated to have more than an insubstantial or speculative effect on the chemical, physical, and biological integrity of the nearest downstream traditionally navigable water. WestLand Resources, Inc., prepared requests for Approved Jurisdictional Determinations (AJDs) for both the east and west (of the Santa Rita Mountains) sides of the Rosemont Copper Project, and evaluated the potential chemical, physical, and biological connectivity between the project area ephemeral drainages and Study Reach B of the Santa Cruz River. This sampling and analysis plan (SAP) has been developed to supplement the analyses performed in the West Side AJD through additional data collection and analysis.

# 2. SAMPLING AND DATA COLLECTION OVERVIEW

## 2.1 SAMPLING PROCEDURES

In order to analyze the potential connectivity of the west side project area to the Santa Cruz River, sampling will be completed in two general areas: 1) in the Helvetia area drainages located on the west flank of the Santa Rita Mountains and 2) the Pima County Ina Road wastewater treatment plant (WWTP). Sampling for both chemical and biological factors will be performed in the drainage originating in the vicinity of the Rosemont-owned properties near Helvetia. Additional chemical sampling will occur in drainages originating near the Imerys marble quarry and Peach Knob Hill area north of Helvetia, as well as the drainage below the Ridley Mine south of Helvetia. Physical connections from the Helvetia area drainage to the Santa Cruz River will be traced. Sampling (water and soil) of chemical factors will be performed in the Santa Cruz River drainage receiving discharge from the Pima County Ina Road WWTP. Sampling results from the drainage below the WWTP will be used as a proxy for potential chemical connectivity from Rosemont's west side properties to the Santa Cruz River.

The purpose of this SAP is to describe the procedures for the collection of soil and water samples.

Soil samples are to be collected on the top one (1)-inch of soil to limit surface disturbance, excluding rocks and pebbles. Surface samples will be collected using a small scoop. The procedures listed herein are those typically used and may be changed as required depending on site conditions. The actual procedures used should be documented in the sampling report.

### 2.1.1 Helvetia Area Drainages

The focus of the analyses associated with the drainages originating in the vicinity of the Rosemont-owned properties on the west side of the Santa Rita Mountains will be three (3) key drainages and two (2) sub drainages. These drainages include:

- Drainage 1: The drainage that originates within and above the main Helvetia area;
- Drainage 2: The drainage that originates near the Ridley Mine;

- Drainage 3: The drainage that comes from the Peach Knob Hill and Imerys marble quarry area; and

- Drainage 4a, 4b: Two sub-drainages in vicinity of the Tip Top mine in the Peach Knob Hill area.

Depending on the location, chemical and biological factors will be addressed by taking and analyzing soil samples obtained from within the drainages. **Figures 1, 2, 3 and 4** show the anticipated soil sampling locations along Drainages 1, 2, 3 and 4. Field observations will also be taken to supplement sample collection and analysis. Other field observations will be taken as needed to address physical factors, such as documenting drainage paths (or impeded paths) to the Santa Cruz River.

The following sections describe the chemical, physical, and biological factors to be documented along these drainages.

#### *2.1.1.1 Chemical Factors: Sample Locations and Procedures*

For the drainages mentioned above, the sampling team will collect soil samples within the drainages as described below. Soil sampling will be generally concentrated downstream of potential sources of chemicals (Columbia Smelter, Ridley Mine, and Tip Top Mine), then taper off downstream, reducing the frequency of sampling. Sample locations shown on the figures will be field modified as needed to include drainage junction points or other as needed features, such as the start and end of residential areas.

Samples will be collected in the drainages as follows:

- Helvetia/Copper World drainage (Drainage 1): Sampling will occur every 0.25 mile starting 0.5 mile (2 samples) above the Columbia Smelter just south of Helvetia, continuing at that interval past the historic Columbia Smelter until the end of the Rosemont property boundary at "F Block". Sampling will then occur at 1-mile intervals for 5 miles and then at 2 mile intervals for approximately 4 miles. The final soil sample will be taken at the Santa Cruz River as access permits.

- Ridley Mine drainage (Drainage 2): Initial soil samples will be taken 0.5 mile upstream (2 samples) prior to the Ridley Mine. Two soil samples will be taken within the potential source of chemicals, within the tailings of the mine. Sampling will occur just below the mine within the wash channel at an initial interval of 100-feet for a total of 500-feet. The next sample will be at 500-feet and then continue every 1 mile for approximately 12 miles until the final sample is taken within the Santa Cruz River.

- Imerys marble quarry drainage (Drainage 3): Sampling will start on Rosemont private land ("F-Block") in the drainage below the marble quarry. Sampling will occur every 0.25 mile through the Rosemont property, then reduce samples to every 1 mile for 5 miles past the property boundary where it converges with Drainage 1. An additional sample is planned below the confluence with Drainage 4a, a drainage below Tip Top Mine. Note: The drainage from the Tip

Top Mine area also connects into the Imerys marble quarry drainage (Drainage 3) via Drainage 4b.

- Tip Top Mine drainages (Drainage 4a and 4b): The Tip Top mine is located on Peach Knob Hill. Two source samples will be collected within the tailings of Tip Top mine on each side of the ridgeline. These sample locations will be selected to include the most likely materials to be transported downstream. The drainages that run east and west of the Tip Top mine will each be sampled beginning with a sample immediately below the mine tailings. Sampling will then continue at an interval of 100-feet for a total of 500-feet. The next sample will be at 500-feet and then continue every 0.25 miles until the drainage converges with the drainage coming from Imerys (Drainage 3).

- Additional sampling will occur where access permits downstream of Imerys marble quarry in an additional drainage that runs northwest near Wilmot Road and Sahuarita Road. Sampling will also occur where access permits along Sahuarita Road and Dawson Road where the Drainage 1 route appears to be altered by road construction.

A minimum of a 150-gram soil sample (or the volume of a sandwich bag) will be collected at each soil sampling location. A minimum of 500-gram soil samples will need to be collected where biological samples are conducted in Drainage 1. The samples will be collected using a small scoop using the following methodology:

- A 3-foot diameter circle (hula hoop) will be placed in the middle of the drainage, and along both margins of the channel at the designated soil sampling location;

- Remove extraneous surface material, such as rocks, glass, vegetation. Soil samples should not include particles larger than can pass through a No. 5 sieve;

- Near-surface soil samples (1-inch depth) will be taken with a small scoop (leveled tablespoon) from 5 points within each of the 3 circles as shown on **Illustration 1**;

- A composite sample will be thoroughly mixed within a bowl, sieved with a No. 5 sieve;

- Separate a small portion of the sample (2-3 teaspoons), add water to this portion of the sample to make the sample moist, and collect soil color (hue, value, chroma) in the field using the Munsell Color Chart.

- The remainder of the composited sample material (sandwich bag volume) will be placed in a zip lock bag and labeled for lab analysis. The sample shall be recorded on a chain of custody prior to submittal to the soil laboratory.

- In Drainage 1, where biological samples will be collected, in addition to the soil sample collected as described above, place 3 to 4 composite sample locations within the root zone or crown of the mesquite tree selected for sampling, spaced evenly around the mesquite tree (or alternative plant species). At these locations, a total of 9 samples will be collected within each hula hoop as seen in **Illustration 2**, then sieved and placed into a sample size. A portion of the sample will be extracted to obtain the soil color using the Munsell color chart. A total sample size of 500-grams of material (sandwich bag volume) will be placed in a zip lock bag and labeled for analysis. The samples will be recorded on the chain of custody form.

- Discard any unneeded sample where removed.

- The soil scoop, sieve, and mixing bowl will be decontaminated between each sample location by spraying Alconox, then triple rinsing with distilled water. Dry between sample locations.

- Observe and note the characteristics of the sample and sampling area on the provided form. Record any striking differences that may suggest a high variability in the subsequent analysis (i.e., abrupt color or texture change, presence of ash or other foreign substance, etc.).

- A photograph of each soil sample location will be taken with a photo identification label on a dry erase board placed next to the soil hoop, capturing the whole cross section of the wash.

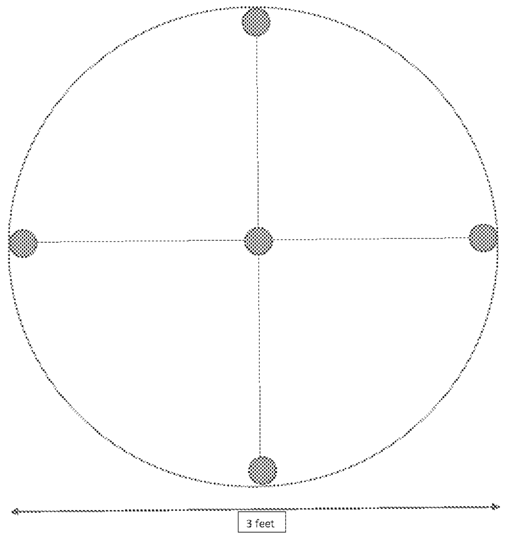



**Illustration 1. Soil Sampling Methodology (sample points).**

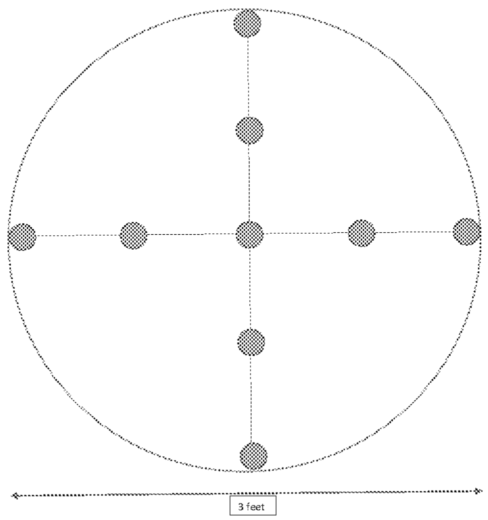



**Illustration 2. Soil Sampling Methodology for Biological Samples (sample points).**

#### *2.1.1.2 Physical Factors: Locations and Procedures*

An environmental scientist will document the path of the various drainages flowing across Rosemont's private land to the Santa Cruz River. However, if the drainage is blocked by roads or ends in agricultural fields then that condition will also be documented, photographed, and a GPS location will be collected.

The scientist will document all potential flow paths flowing across or from Rosemont's property, not just those drainages shown on **Figures 1, 2, 3 and 4**. GPS tracks will be recorded in areas where flow was investigated by hiking the drainage, tracing the active channel by identifying the lowest (in elevation) path within the drainage. The analysis performed for the West Side AJD documents will also be reviewed for pertinent information on potential drainage paths. GIS investigation may further determine flow direction based on digital elevation models (DEMs) or Lidar surveys may be conducted in selected areas.

While navigating washes for soil sample collection, the soil sampling team will document any potential obstructions to water flow, including road crossings and stock tanks. If field reconnaissance of drainage paths differs from the planned drainage route, the discrepancy will be relayed to the field supervisor to investigate and update the sampling plan to accurately reflect the actual drainage path.

A GIS analysis using Normalized Difference Vegetation Index (NDVI) will be conducted to detect a color signature in Drainage 3 and other flow paths coming from the Imerys marble quarry. The flow path distance will be calculated to determine if limestone from the quarry has a physical connection to the Santa Cruz River.

#### *2.1.1.3 Biological: Sample Location and Procedures*

In Drainage 1, the sampling team will collect live plant matter for analysis of potential uptake of chemical constituents (phytoextraction; **see Illustration 3**). Plants selected for analysis are anticipated to occur within the high-water mark of the drainage. Different species extract different elements from the soils. The species selected for biological sampling will ideally be a hyperaccumulator, capable of absorbing high levels of metals within their roots, shoots, and/or leaves as compared to non-hyperaccumulators which uptake and store metals only within their roots. The species selected for analysis is the velvet mesquite (*Prosopis velutina*). This species is widespread throughout the area, likely to occur at most sampling locations.

When selecting the soil sampling location, plants present at the location should also be considered and the sampling location can be move accordingly (+/-100 feet, except for locations near potential chemical sources). For each plant sample, collect 60 to 100 leaves (~10 grams). Collect fully matured leaves. Record if the plant is stressed. Note insect damage or disease on the plant. Use a paper bag to collect the sample, recording the sample ID on the bag with a permanent marker and also record it on the chain of custody.

Three (3) controls of each species used will be taken from an upland area, away from the potential path of chemicals down a stream and where disturbances are not observed. Control locations will be photographed and GPS coordinates taken. The soils of the control sites would ideally be non-contaminated, containing lower levels of metals as compared to the drainages. Likewise, if plants are extracting metals from the soil, it would be expected for the leaves to contain higher levels of metals in the drainages as compared to the control sites.

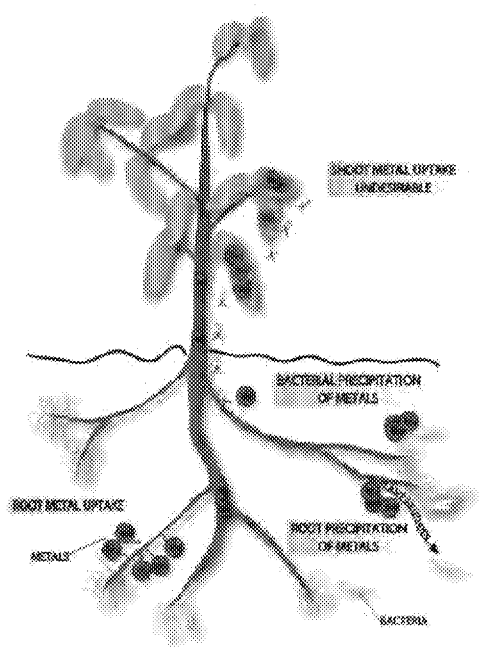



**Illustration 3. Phytoextraction Process (Mendez & Maier, 2008).**

### 2.1.2 Ina Road WWTP

Discharges from the Ina Road WWTP will be evaluated to ascertain the mobility and transportability of selected analytes in an arid system. Publicly available information will be evaluated from the Arizona Department of Environmental Quality (ADEQ), Pima County Department of Environmental Quality (PDEQ), Pima County Wastewater Reclamation Department (PCWRD), and other sources related to water chemistry in the Santa Cruz River, downstream of the Ina Road WWTP. The data will be reviewed to determine if conclusions can be drawn regarding the mobility of certain analytes, such as nitrogen and phosphorous.

#### *2.1.2.1 Chemical Factors: Locations and Procedures*

The sampling team will collect soil and surface water samples (wastewater effluent) within the Santa Cruz River downstream of the WWTP where access is allowed. A water sample will be collected just prior to the water drying up and where soil samples will start to be collected at or just below that same point as well as below the source (see ***Figure 5***). The sampler will wear nitrile gloves when collecting the water sample, ensuring that any preservatives remain in the bottle while collecting the sample. The sampler will need to fill 1- 250mL No Preservatives bottle, 1- 250mL amber glass bottle, 1- 250mL sulfuric preservatives bottle, and 1- 250mL nitric preservatives bottle at each sampling location. The water sample will be placed in a cooler chest with ice. The sample will be delivered to the analysis lab within 48 hours or less following all sampling efforts associated with the WWTP. Applicable elements of the *Rosemont Copper Project Water Programs Quality Assurance Project Plan (QAPP) – Baseline Conditions* will be followed by samplers.

Soil sampling would continue at 0.25-mile intervals for 2 miles and then at 1-mile intervals for 3 miles (***Figure 5***). Soil sampling would be performed with the same technique as illustrated in **Section 2.2.1.1**. A 150-gram sample (sandwich size bag volume) would be taken. Due to nitrite and nitrate analyses, these soil samples will be kept cold to limit microbial activity and promptly shipped to the analysis lab.

## 2.2 EQUIPMENT

Equipment that is anticipated to be used as part of this sampling effort is described below in Table 1.

**Table 1. Soil Sampling Equipment**

| Description of Supplies | Purpose of Supplies |
|---|---|
| **Documentation Supplies** | |
| Sampling plan/maps/plot plan | Used to follow approved sampling plan and document actual locations of samples. |
| GPS/Survey equipment | |
| Camera, datasheets, logbook, white board, dry erase markers, eraser | |
| Chain of custody forms | For submittal of sample to lab(s) |
| **Sampling Equipment: Soil** | |
| Soil sieve, mixing bowl | To remove surface vegetation, rocks, debris & composite sample together. |
| Soil scoop | Disposable and/or stainless steel. |
| Munsell Color Chart | To provide consistent color in logs. |
| **Containers & Packaging Supplies** | |
| Plastic bags (sandwich sized ziplock bags, double bag) | Appropriate size depending on analyses to be performed. |
| Paper bags, clippers | To remove leaves from plants, place leaves in bag |
| Labels & marking pens | To uniquely identify samples. |
| Bubble wrap/cushioning materials | To protect samples from ice. |
| Shipping tape | To seal shipping container. |
| Custody seals & chain-of-custody | To maintain & document sample integrity. |
| Bucket | For storing and shipping sample |
| **Decontamination Supplies** | |
| Detergent sprayer, Alconox, brush & distilled water | To clean & rinse sampling equipment. |
| Paper towels/wipes | To speed dry equipment. |
| Plastic sheets/bags | To protect equipment from contamination. |
| Large trash bags | To collect discarded supplies & equipment. |
| **Water Sampling Supplies** | |
| Nitrile gloves | |
| Lab-supplied bottles | To place the water sample in, which includes preservatives if needed. |
| Cooler, Ice | Store water sample in cooler surrounded by ice. |

## 3. TEST METHODS AND LABORATORIES

Table 2 (below) describes the test methods to be used to assess soil, water and plant samples collected as part of the present program. Methods of analysis are selected to provide description of specific aspects of potential connectivity, as described below.

EPA Method 1312/6010: Synthetic Precipitation Leaching Procedure. This method will be used to characterize chemical constituents that may be mobilized from the western flank of the Santa Rita foothills that are transported dissolved in water. Adsorption and chemical precipitation from solution may deposit these constituents in easily mobilized phases of the soils/sediments. SPLP, a relatively gentle leach procedure will recover most of these. Method 6010 analysis will produce detection limits sufficiently low to gauge trends within the overall drainage sample set.

EPA Method 3050/6010: Acid Digestion of Sediments, Sludges and Soils. Digestion with method 3050 will leach constituents from all but the most chemically resistant phases. Method 6010 analysis will produce detection limits sufficiently low to gauge trends within the overall drainage sample set.

Standard methods of wastewater analysis (see Table 2) will be used to characterize water samples collected that are associated with the Ina Road Water Treatment Plant and compared against the Arizona Department of Environmental Quality (ADEQ) "Santa Cruz River (EDW) – Agua Nueva Outfall to Baumgartner Road segment": Partial Body Contact (PBC) and Aquatic and Wildlife – effluent dependent water (EDW) standards.

Analyses for soil and plant samples will be conducted by ACZ Laboratories in Colorado.

Analyses for water samples will be conducted by Turner Laboratories in Tucson, Arizona.

**Table 2. Analytical Methods**

| Media | Location | Parameter | Test Method | Quantity |
|---|---|---|---|---|
| Soil | All | pH, EC | Paste pH, paste EC (or Arizona equivalent) | 96 + 20 + 13 = 129 |
| Soil | Drainages 1, 2, 3, 4 | Cu, Cd, Ni, As, Se, Mo, Zn, Sb, Pb, Fe, Hg, Al, Mn, Tl, Ca, Mg | Synthetic Precipitation Leaching Procedure (SPLP) EPA 1312 | 96 |
| | | Total inorganic carbon | LECO | 96 |
| | | Total Sulfur | ASTM E1915-11: LECO furnace | 96 |
| | | Cu, Cd, Ni, As, Se, Mo, Zn, Sb, Pb, Fe, Hg, Al, Mn, Tl, Ca, Mg | EPA 3050B: Acid Digestion of Sediments, Sludges and Soils | 96 |
| Soil (Sample collected under plant) | Drainage 1 | Soil texture/grain sizes | Hydrometer | 20 |
| | | Total organic matter | Combustion or wet weight (%) | 20 |
| | | plant-available: Cu, Cd, Ni, As, Se, Mo, Zn, Sb, Pb, Fe, Al, Mn, Ca, Mg | AB-DPTA; EPA 300, 6010D; | 20 |
| | | Cu, Cd, Ni, As, Se, Mo, Zn, Sb, Pb, Fe, Al, Mn, Ca, Mg | Synthetic Precipitation Leaching Procedure (SPLP) EPA 1312 | 20 |
| | | Cu, Cd, Ni, As, Se, Mo, Zn, Sb, Pb, Fe, Al, Mn, Ca, Mg | EPA 3050B: Acid Digestion of Sediments, Sludges and Soils | 20 |
| **Plants (Leaves)** | Drainage 1 | Cu, Cd, Ni, As, Se, Mo, Zn, Sb, Pb, Fe, Al, Mn, Ca, Mg | Complete digestion/total concentrations | 20 + 3 controls |
| Soil | Ina Road WWTP | $NO_3$, $NO_2$, P, $SO_4$, $HCO_3$ | EPA 300.0, EPA 6010D | 13 |
| | | Total organic carbon (TOC) | Combustion (ASA 9 29-2.2.4) | 13 |
| | | Total inorganic carbon | LECO | 13 |
| | | Cu, Cd, Ni, As, Se, Mo, Zn, Sb, Pb, Fe, Hg, Al, Mn, Tl, Mg | Synthetic Precipitation Leaching Procedure (SPLP) EPA 1312 | 13 |
| | | Cu, Cd, Ni, As, Se, Mo, Zn, Sb, Pb, Fe, Hg, Al, Mn, Tl, Mg | EPA 3050B: Acid Digestion of Sediments, Sludges and Soils | 13 |
| | | S | LECO: ASTM E1915-11 for Sulfur | 13 |
| Water | Effluent stream from Ina Road WWTP | Total P, $NO_3$, $NO_2$, $SO_4$, $HCO_3$, DOC (dissolved organic carbon), Cu, Cd, Ni, As, Se, Mo, Zn, Sb, Pb, Fe, Hg, Al, Mn, Tl | SM 1030E ($NO_3$, $NO_2$) EPA 365.1 (P) EPA 415.2 (DOC) EPA 200.7, 200.8, 245.1 | 2 |

# 4. SAMPLE COLLECTION

## 4.1 SAMPLE PRESERVATION, CONTAINERS, HANDLING AND STORAGE

Chemical preservation of soil is not recommended. Soil samples should be protected from sunlight to minimize potential reaction or minimize biological activity. Water samples will be collected in lab-supplied bottles with as needed preservatives.

## 4.2 INTERFERENCES AND POTENTIAL PROBLEMS

Cross contamination and improper sample collection are potential problems associated with this sampling project. Cross contamination can be eliminated using disposable equipment that is used once for each sample location or sample type then discarded. Reusable equipment requires adequate cleaning between uses. Improper collection can also result in insufficient homogenization.

Soil scoop, sieve, mixing bowl, and clippers will be decontaminated between sample locations by spraying Alconox, then triple rinsing with distilled water. Dry between sample locations.

## 4.3 QUALITY ASSURANCE/QUALITY CONTROL

The following general quality assurance (QA) procedures apply:

1. All data must be documented on field sheets or logbooks.

2. All instruments must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout must occur prior to sampling/operation and must be documented.

3. Duplicates. For every 10 samples collected, a duplicate sample will be collected. At these locations, a total of 300-gram soil will be composited and split into 2 – 150-gram samples. The labels should not indicate that it is a duplicate, but duplicates should be recorded on the field sheets. Duplicate names have been determined prior to field collection. For plant samples, the same individual plant should be used for obtaining the second duplicate sample. No duplicates will be collected for the water samples. However, 2 samples will be taken of the effluent.

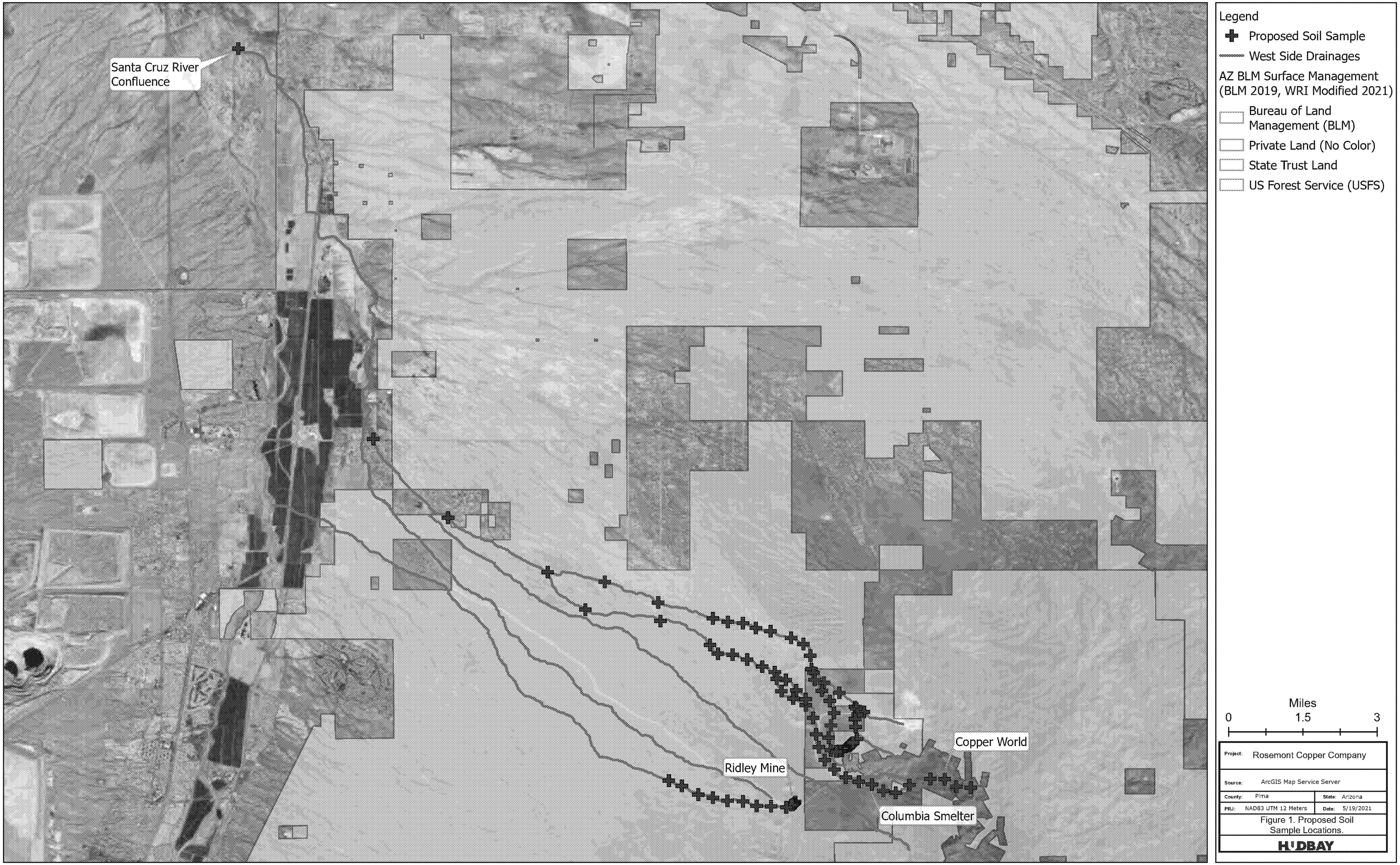
   A total of 13 soil samples located along the Ina WWTP, including 1 duplicate sample. A total of 96 soil samples will be collected on the west side of the Santa Ritas, including 9 duplicate samples. There are potentially 19 biological sampling locations (depending on if a mesquite tree is present at each soil sampling location); 1 biological duplicate sample will be collected.

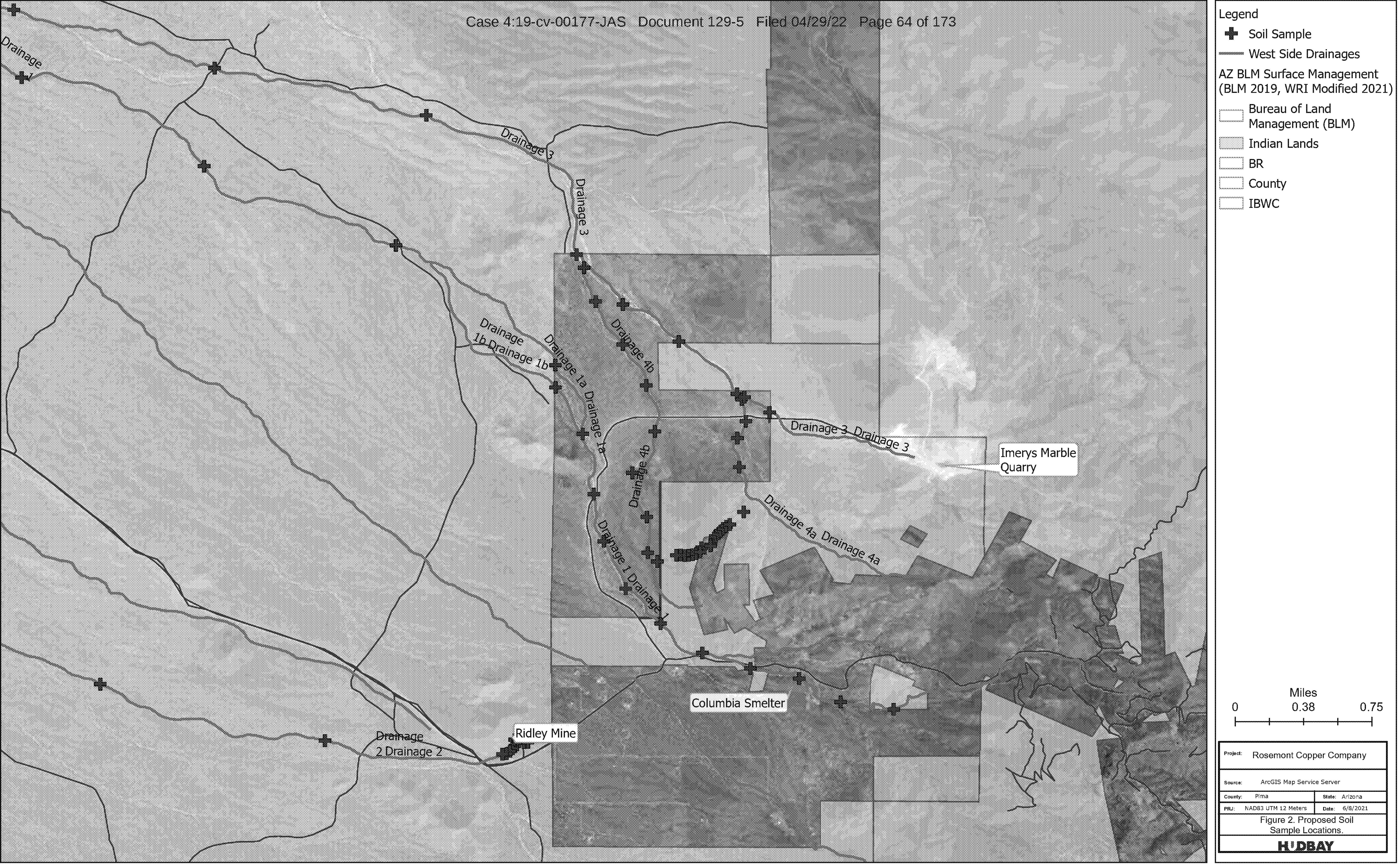
## 4.4 TRACKING AND HANDLING PROCEDURES

For each complete sampling event, a chain-of-custody form, as supplied by the analytical laboratory, must be completed, and included with the sample containers. Storage and holding times for the samples will be according to the direction of the laboratory. Soil samples and biological samples will be shipped and tracked to the analytical lab. The water sample will be hand delivered by the sampling team to a local laboratory.

## 5. REFERENCES

Mendez, M. and Maier, R. 2008. *Phytostabilization of Mine Tailings in Arid and Semiarid Environments – An Emerging Remediation Technology*. Environmental Health Perspectives. Vol. 116: 3. P. 278 – 283.


Santa Cruz River Confluence
Ridley Mine
Copper World
Columbia Smelter
Legend
Proposed Soil Sample
West Side Drainages
AZ BLM Surface Management (BLM 2019, WRI Modified 2021)
Bureau of Land Management (BLM)
Private Land (No Color)
State Trust Land
US Forest Service (USFS)
Miles
0
1.5
3
Project: Rosemont Copper Company
Source: ArcGIS Map Service Server
County: Pima
State: Arizona
PRJ: NAD83 UTM 12 Meters
Date: 5/19/2021
Figure 1. Proposed Soil Sample Locations.
HUDBAY


Drainage
Drainage 3
Drainage 3
Drainage 1b Drainage 1b
Drainage 1a Drainage 1a
Drainage 4b
Drainage 4b
Drainage 3 Drainage 3
Imerys Marble Quarry
Drainage 4a Drainage 4a
Drainage 1 Drainage 1
Columbia Smelter
Ridley Mine
Drainage 2 Drainage 2
Legend
Soil Sample
West Side Drainages
AZ BLM Surface Management (BLM 2019, WRI Modified 2021)
Bureau of Land Management (BLM)
Indian Lands
BR
County
IBWC
Miles
0 0.38 0.75
Project: Rosemont Copper Company
Source: ArcGIS Map Service Server
County: Pima
State: Arizona
PRJ: NAD83 UTM 12 Meters
Date: 6/8/2021
Figure 2. Proposed Soil Sample Locations.
HUDBAY

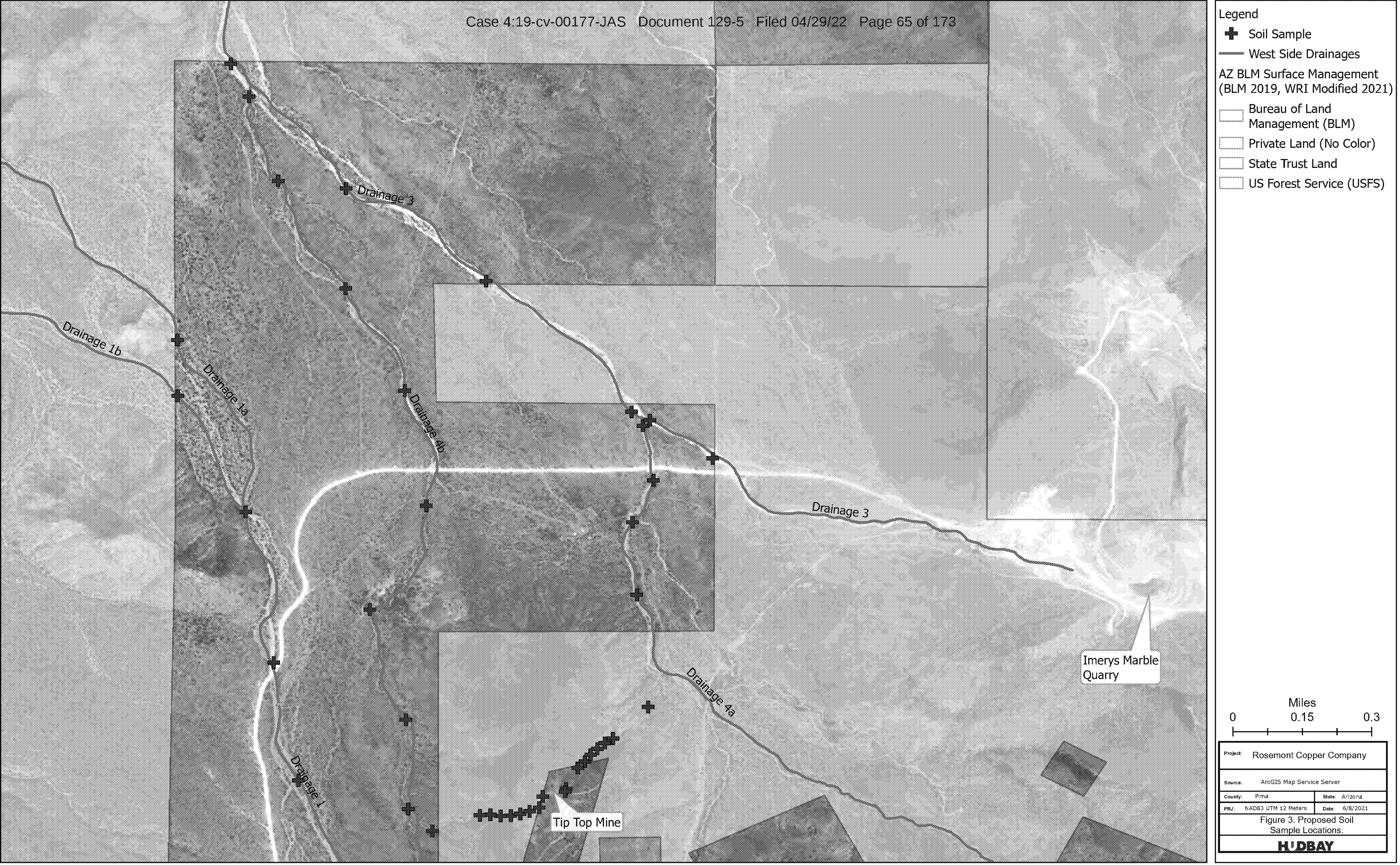
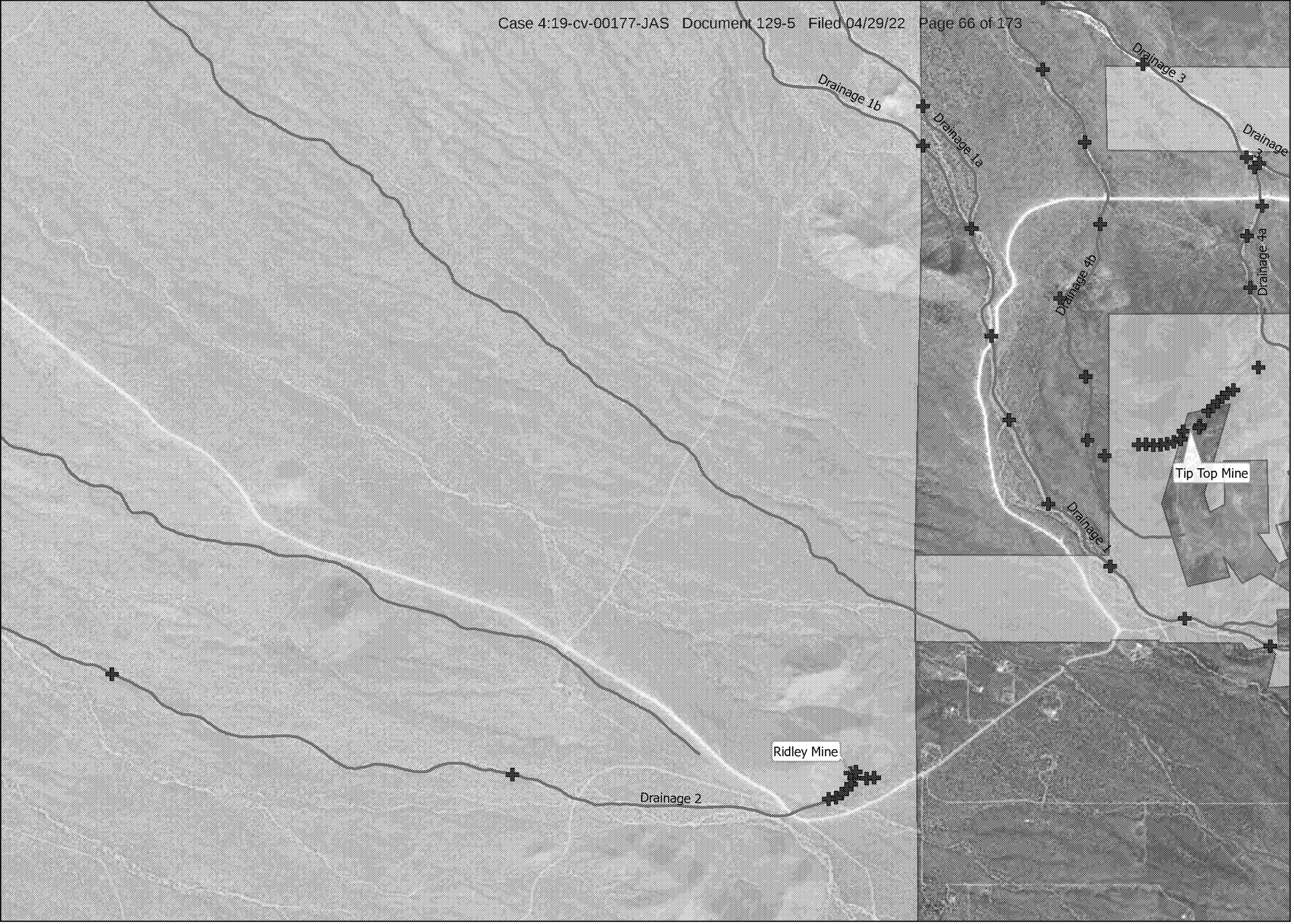


Figure 3. Proposed Soil Sample Locations.




Legend
- Soil Sample
- West Side Drainages

AZ BLM Surface Management (BLM 2019, WRI Modified 2021)
- Bureau of Land Management (BLM)
- Private Land (No Color)
- State Trust Land
- US Forest Service (USFS)

Miles
0 0.25 0.5

| | |
|---|---|
| Project: Rosemont Copper Company | |
| Source: ArcGIS Map Service Server | |
| County: Pima | State: Arizona |
| PRJ: NAD83 UTM 12 Meters | Date: 6/8/2021 |
| Figure 4. Proposed Soil Sample Locations. | |
| HUDBAY | |

Figure 5. Ina Wastewater Treatment Sampling.

# ATTACHMENT B

Source of metal contamination increase downstream of the Helvetia Mining District at Sahuarita Road

| | |
|---|---|
| **To:** | Andre Lauzon |
| | |
| **Cc:** | David Krizek, Clarissa Barraza |
| | |
| **From:** | Matt Cunningham |
| | |
| **Department:** | Environmental, Geology, Engineering |
| | |
| **Date:** | 22Sept2021 |
| | |
| **Subject:** | Source of metal contamination increase downstream of the Helvetia Mining District at Sahuarita Road |
| | |

## SUMMARY

One of the key parameters in determining whether the ephemeral washes on Rosemont Copper World Project (Project) site's private land are considered jurisdictional under the Clean Water Act is whether there is a "significant nexus" with a downstream "traditionally navigable water" (TNW). In other words, the washes on private land could be determined to be jurisdictional waters if they have a physical, biological, and chemical connection to a downstream TNW. The purpose of this memorandum is to explain the increase in metal concentrations where a small wash downstream of the Helvetia Mining District crosses under Sahuarita Road. The Helvetia Mining District is over 10 air miles southeast of the sample point and includes Copper World, the Columbia Smelter, and the Tip Top Mine.

Westland Resources and Hudbay Minerals collected sediment samples for a Connectivity Study to determine if and how far sediments were carried downstream the project site by stormwater in the ephemeral drainages. Sampling began at potential chemical sources (the Columbia Smelter, Tip Top Mine, and downstream of a marble quarry) and continued at various intervals downstream to the point D1-19, over 10 air miles northwest the Helvetia Mining District. D1-19 point is located on a side channel near housing developments just north of Sahuarita Road and a few hundred feet east of the intersection of Delgado Road.

Geochemical analysis of sediments yielded decreased metal concentrations with increased distance from the Helvetia Mining District; however metal values increased again at point D1-19 where the wash crossed under the Sahuarita Road a few hundred feet east of the intersection of Delgado Road.

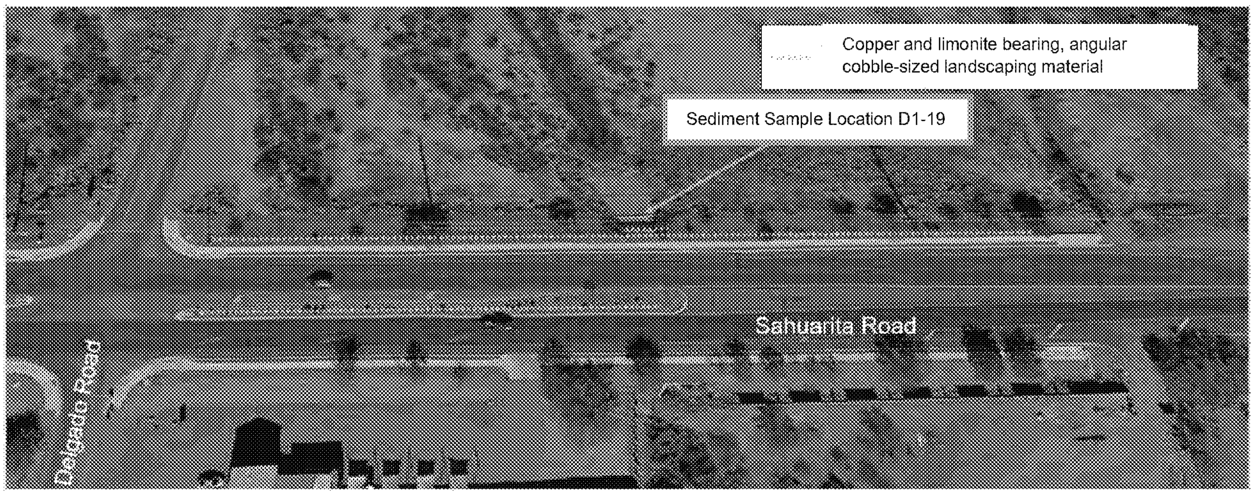



Figure 1: Sample Location and proximal areas likely contributing to higher local metals concentrations.

Several rock samples were collected from the landscaping material used to fill the banks surrounding the concrete culvert and inlet outside the culvert. The rocks are a mix of clastic sedimentary and meta-sedimentary rocks, angular to subangular, cobble size or larger, the majority with conspicuous limonite (iron-oxides), green copper oxides, and/or black oxides. Some of the limonite appears to be from oxidation of sulphide minerals.

For additional verification, the culvert site was revisited on September 21st, 2021. It was confirmed that the rocks analyzed were the same as used in the landscaping material. The same material forms a median on the highway over 300' length, as well as parallel to the sidewalk for over 500' feet in length.

It can be reasonably surmised that the landscaping material was sourced from one of the local open pit copper mines, likely from a waste rock or stockpile location.

It is very reasonable, and likely, the landscaping material releases some metals during rain events, and the landscaping material and run-off water from the roadway is the source of metal concentration increase. The other samples further upstream with lower values indicate the Helvetia Mining District is a negligible source of metal concentrations at this sample location.

Figure 2: Rocks from culvert fill. Conspicuous green copper oxides and dark brown limonite present.

Figure 3: Similar rocks are found over 500' length on either side of the sidewalk on both sides of the culvert. Photo is looking west, taken about 100' east of the culvert.

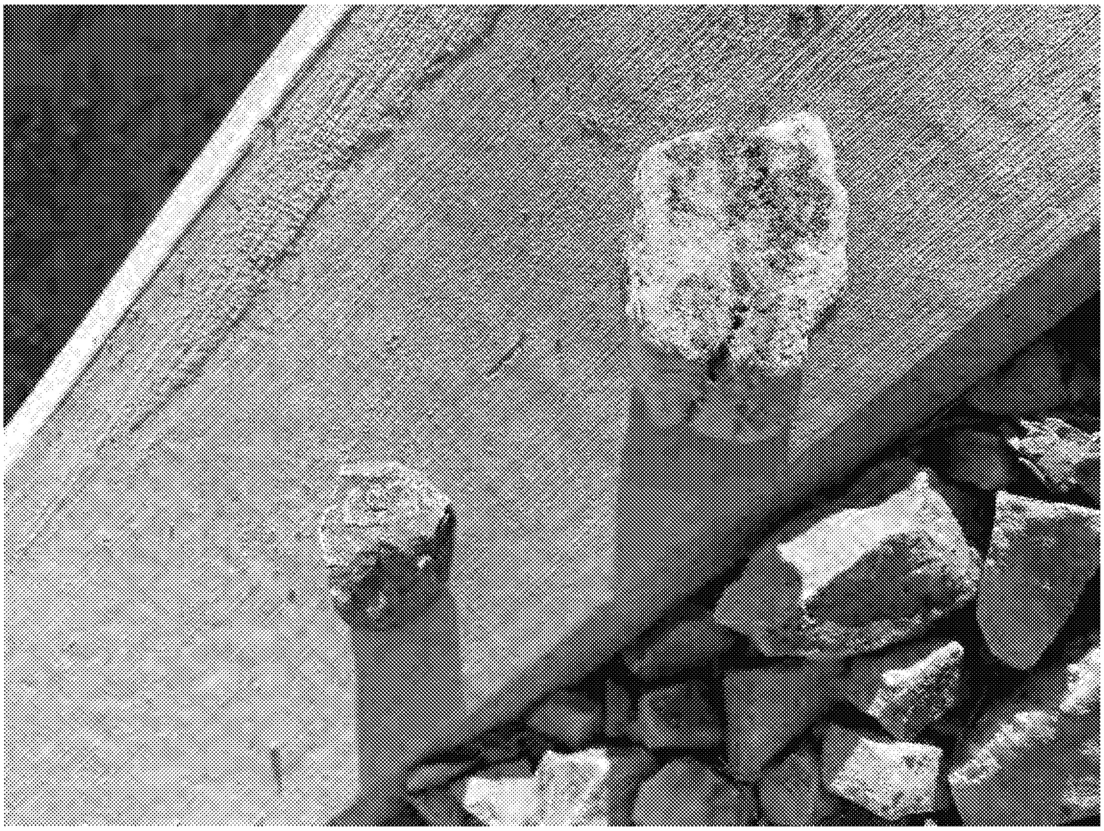


Figure 4: Close up of rocks at culvert. Dark brown limonite on the rock on the right interpreted to be oxidized sulphides.

Figure 5: Addition photos of rocks along sides of the sidewalk.


Figure 6: Photo of site on the sampling date looking upstream. Note the rock material both above and downstream the culvert.


Figure 7: Photo of the site on the sampling date looking downstream.

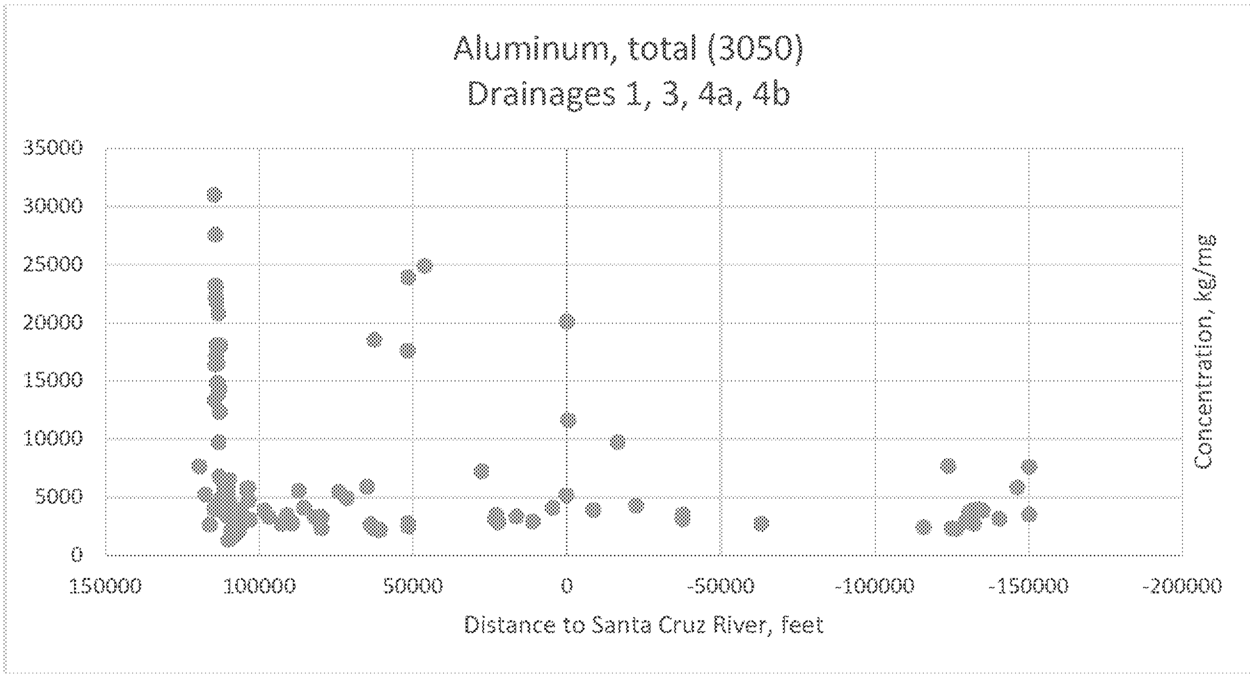
# ATTACHMENT C

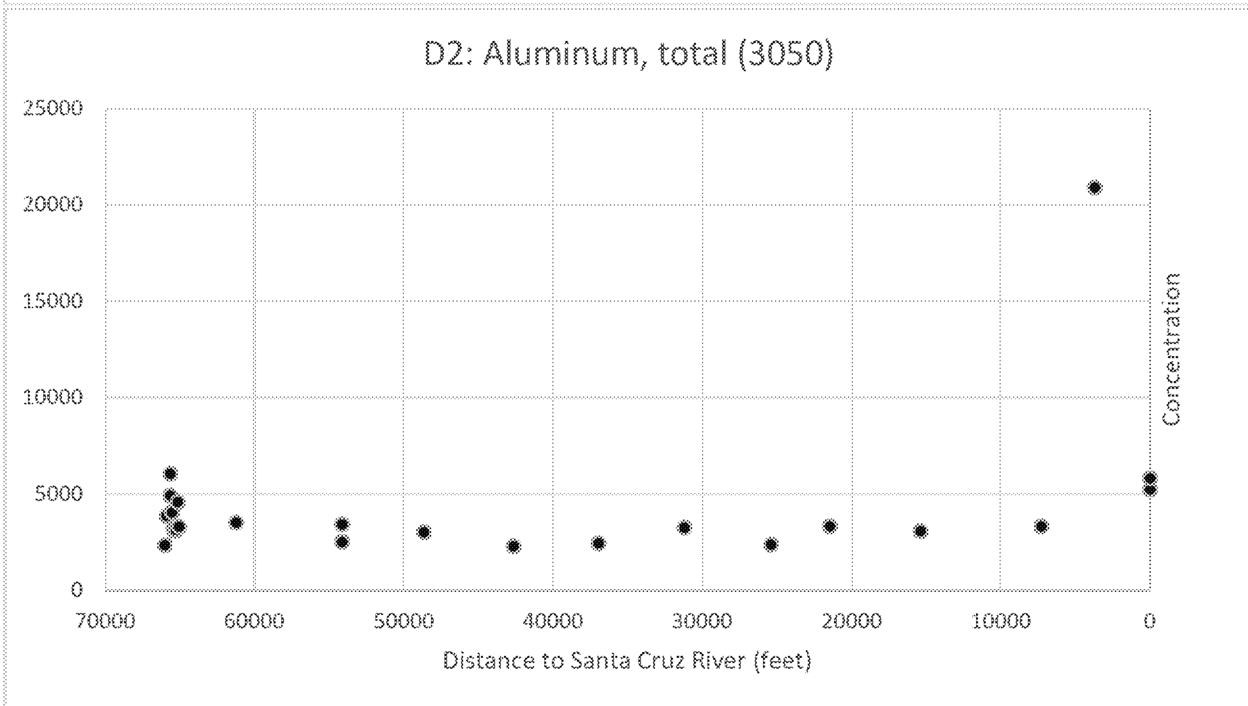
Sediment Graphs

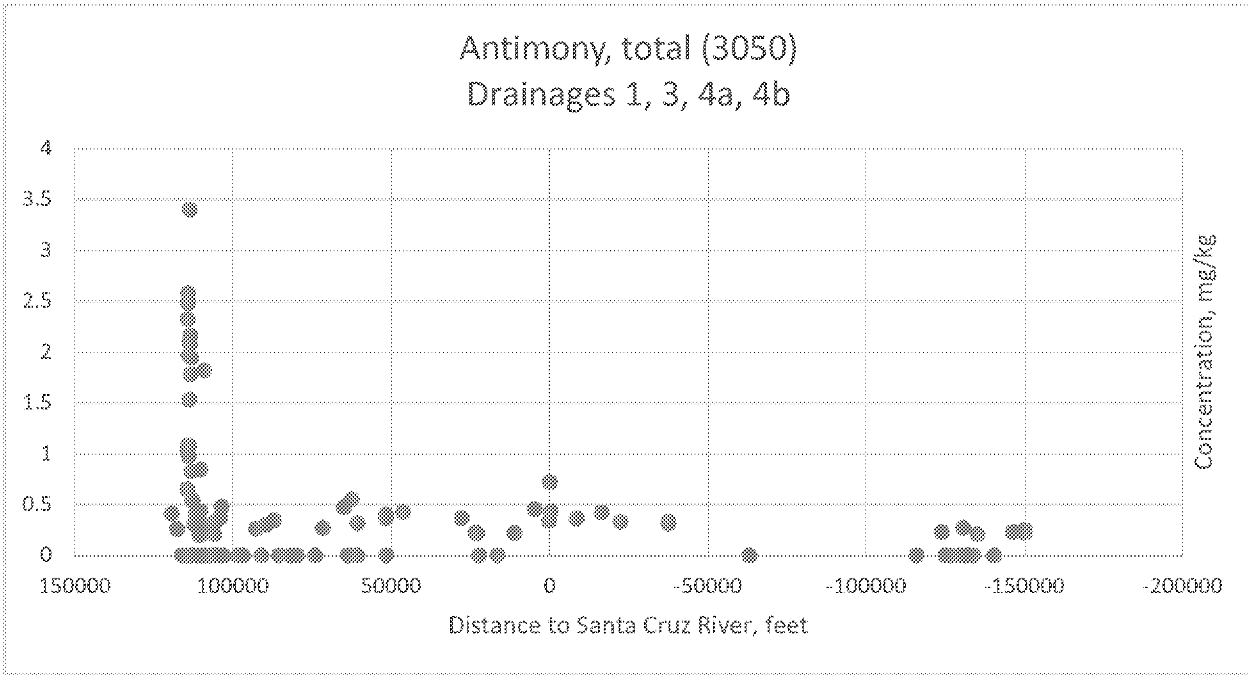
# Sediment Sample Graphs

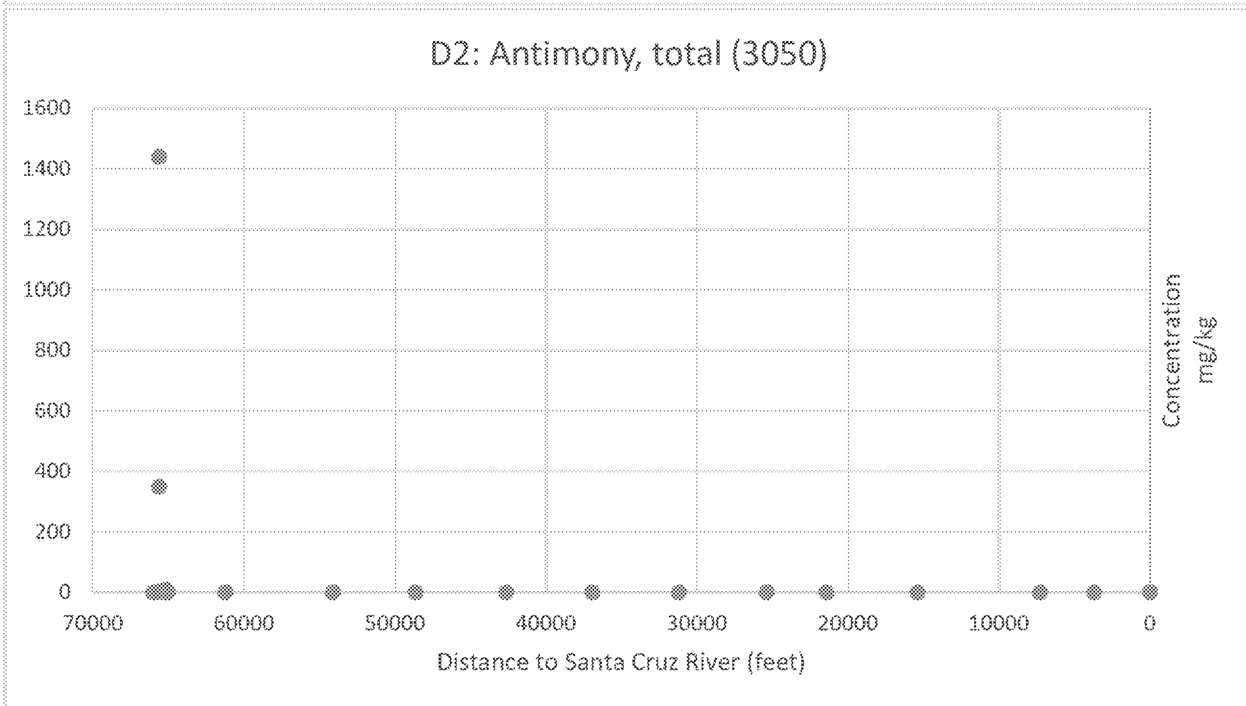
# Total Acid Digestion, Method 3050

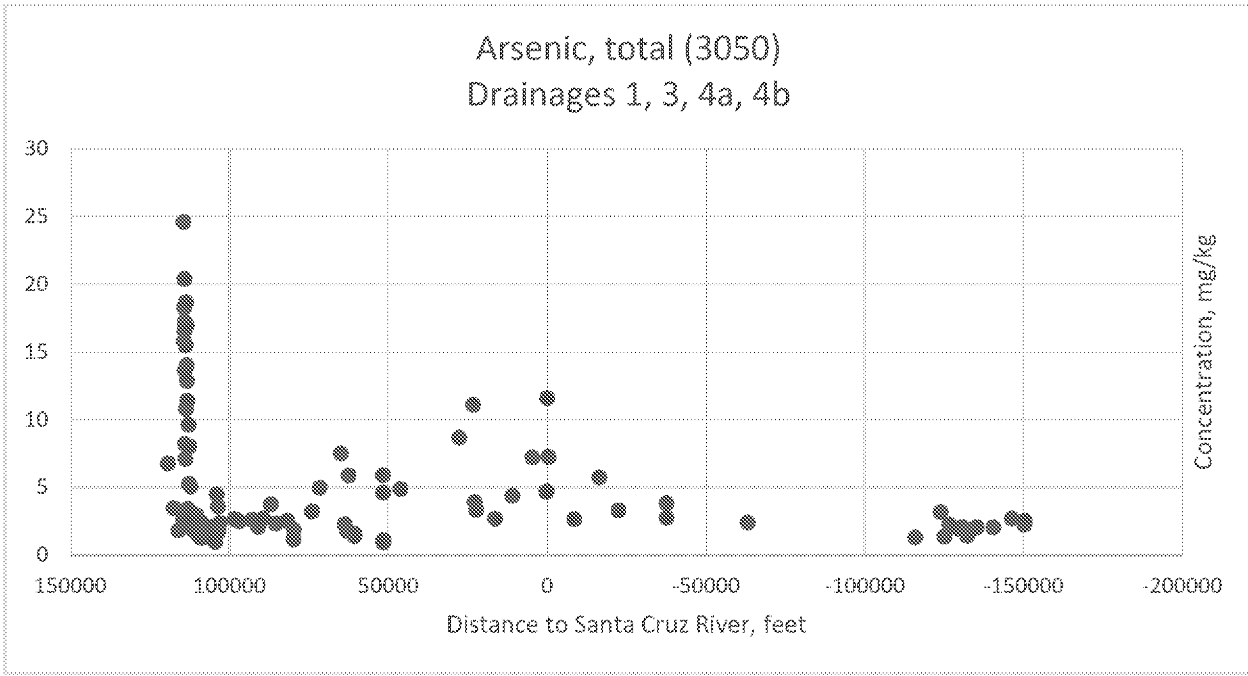
(Presented in milligrams per killigram)

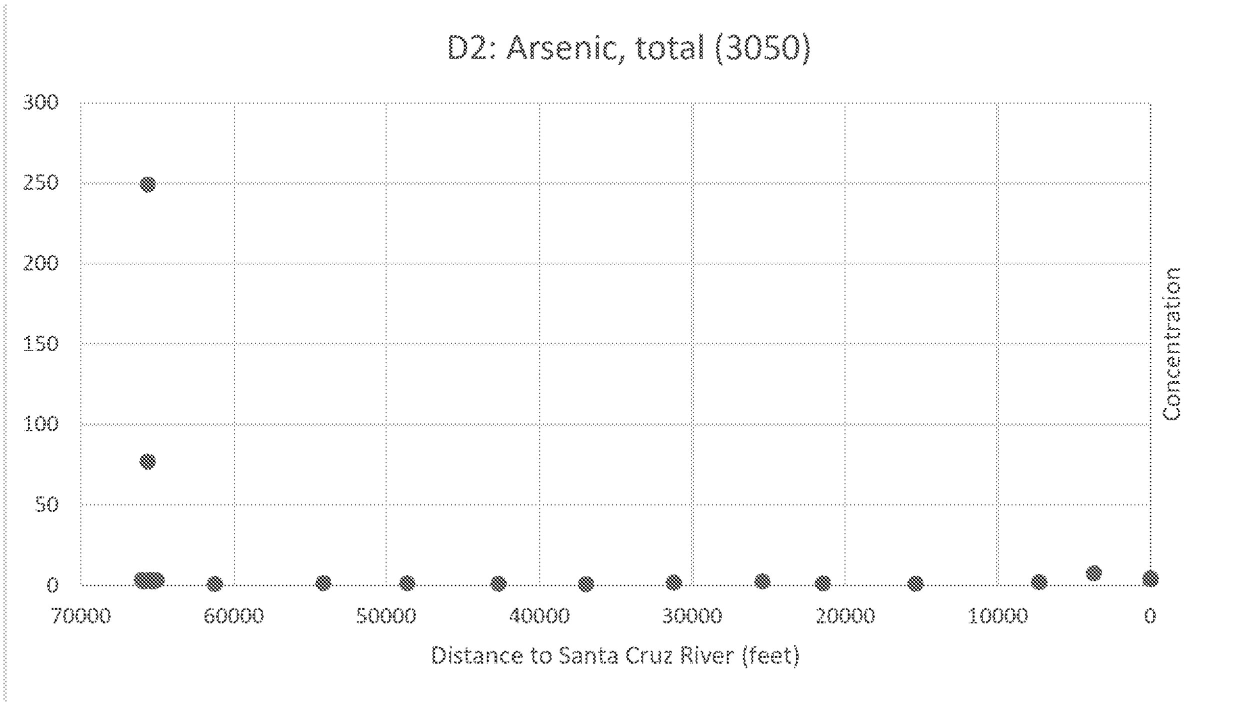



Antimony, total (3050)
Drainages 1, 3, 4a, 4b
4
3.5
3
2.5
2
1.5
1
0.5
0
150000
100000
50000
0
-50000
-100000
-150000
-200000
Distance to Santa Cruz River, feet
Concentration, mg/kg


D2: Antimony, total (3050)
1600
1400
1200
1000
800
600
400
200
0
70000
60000
50000
40000
30000
20000
10000
0
Distance to Santa Cruz River (feet)
Concentration mg/kg


Arsenic, total (3050)
Drainages 1, 3, 4a, 4b
30
25
20
15
10
5
0
150000
100000
50000
0
-50000
-100000
-150000
-200000
Distance to Santa Cruz River, feet
Concentration, mg/kg


D2: Arsenic, total (3050)
300
250
200
150
100
50
0
70000
60000
50000
40000
30000
20000
10000
0
Distance to Santa Cruz River (feet)
Concentration